SAE JOURNAL

FEBRUARY
1953

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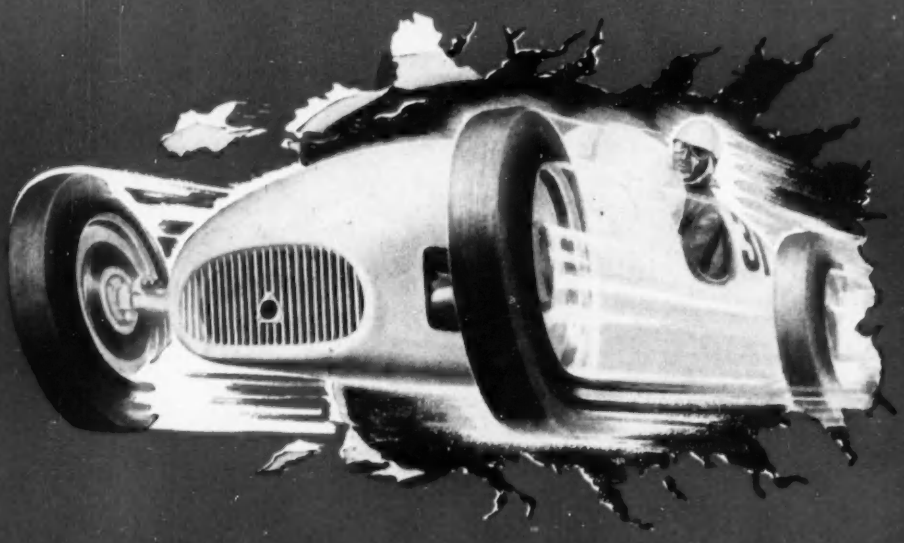
PUBLISHED BY THE SOCIETY OF AUTOMOTIVE ENGINEERS

clean sweep!



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June 8	Milwaukee, Wis.	100 Miles	Mike Nazaruk
July 4	Raleigh, N. C.	200 Miles	Troy Ruttman
Aug. 16	Springfield, Ill.	100 Miles	Bill Schindler
Aug. 24	Milwaukee, Wis.	200 Miles	Chuck Stevenson
Aug. 30	Detroit, Mich.	100 Miles	Bill Vukovich
Sept. 1	DuQuoin, Ill.	100 Miles	Chuck Stevenson
Sept. 1	Pikes Peak, Colo.		George Hammond
Sept. 6	Syracuse, N. Y.	100 Miles	Jack McGrath
Sept. 8	Denver, Colo.	100 Miles	Bill Vukovich
Nov. 2	San Jose, Calif.	100 Miles	Bobby Ball
Nov. 11	Phoenix, Ariz.	100 Miles	Johnny Parsons

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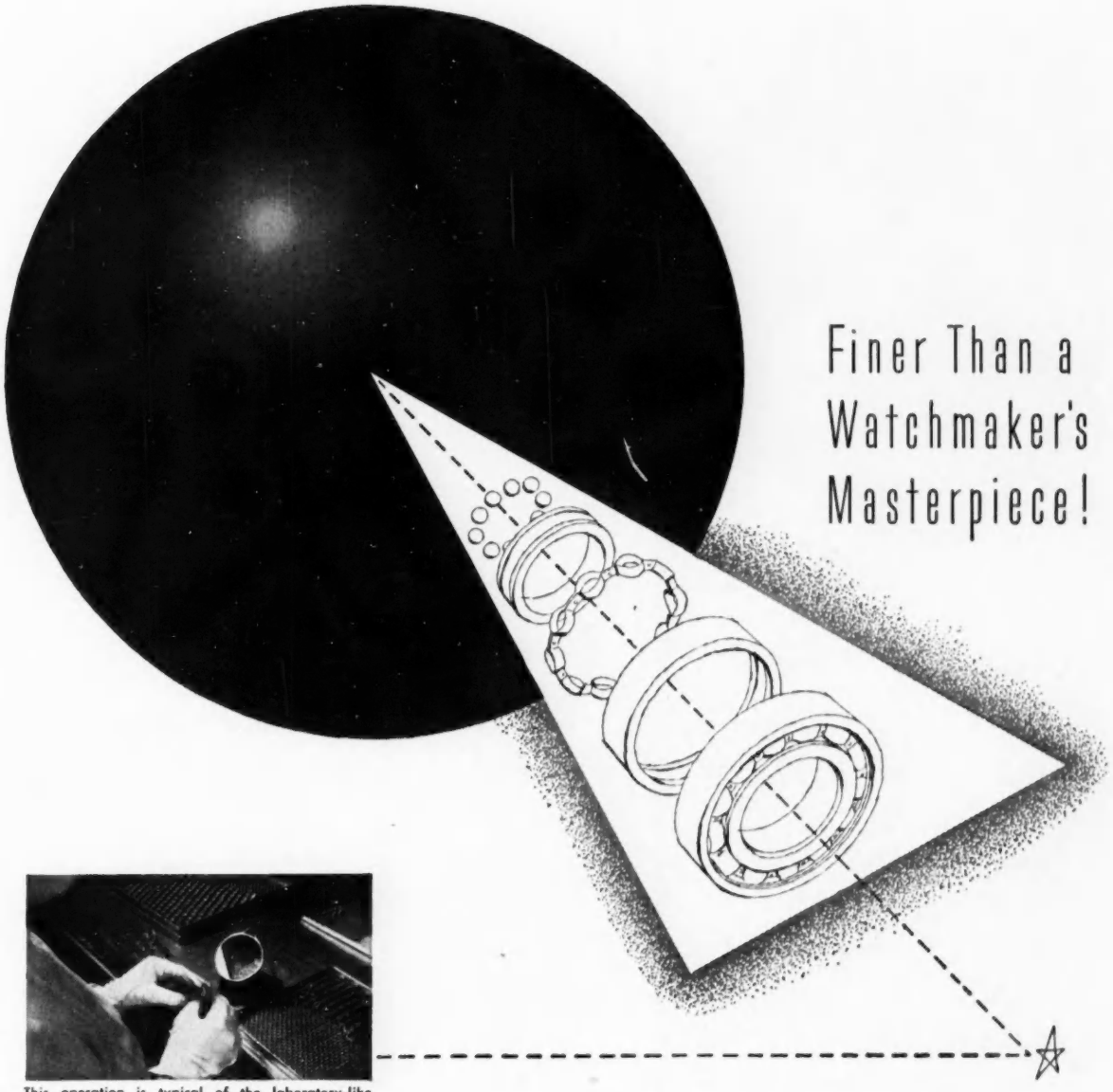

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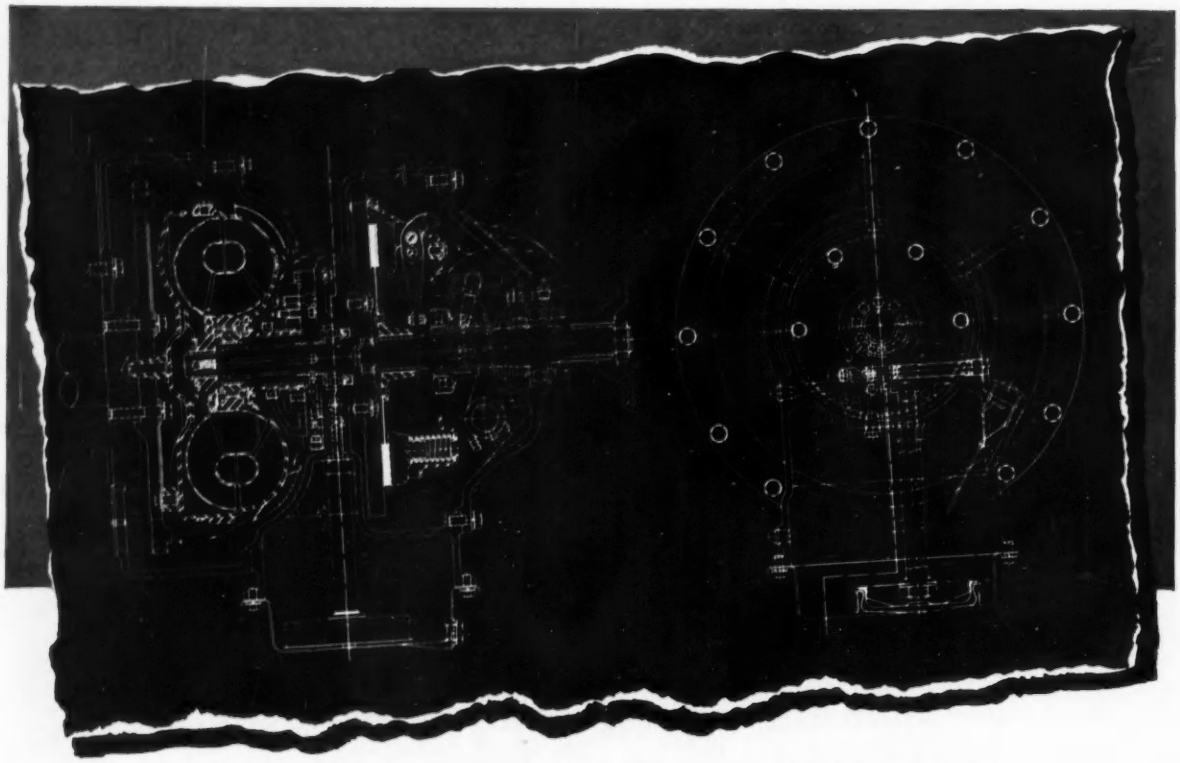

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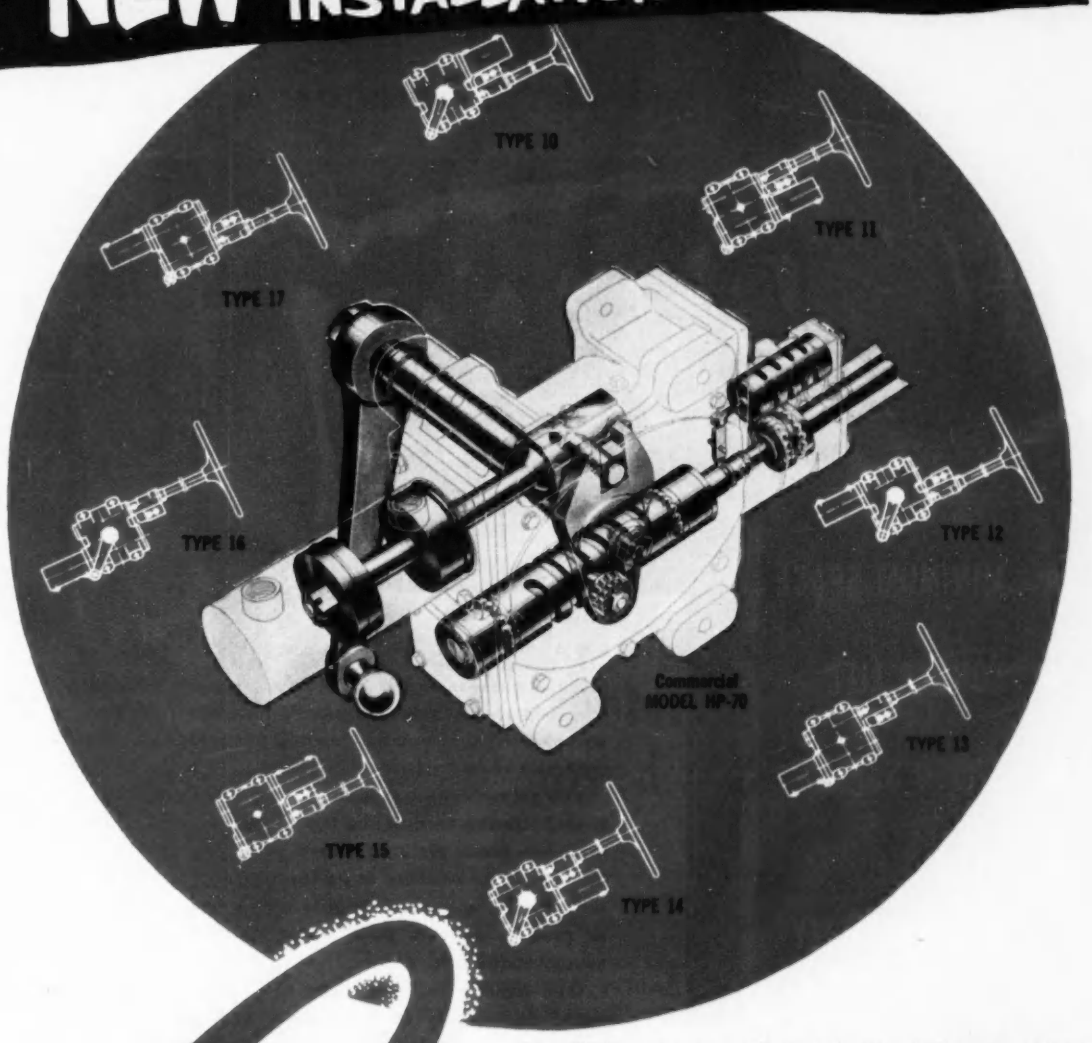

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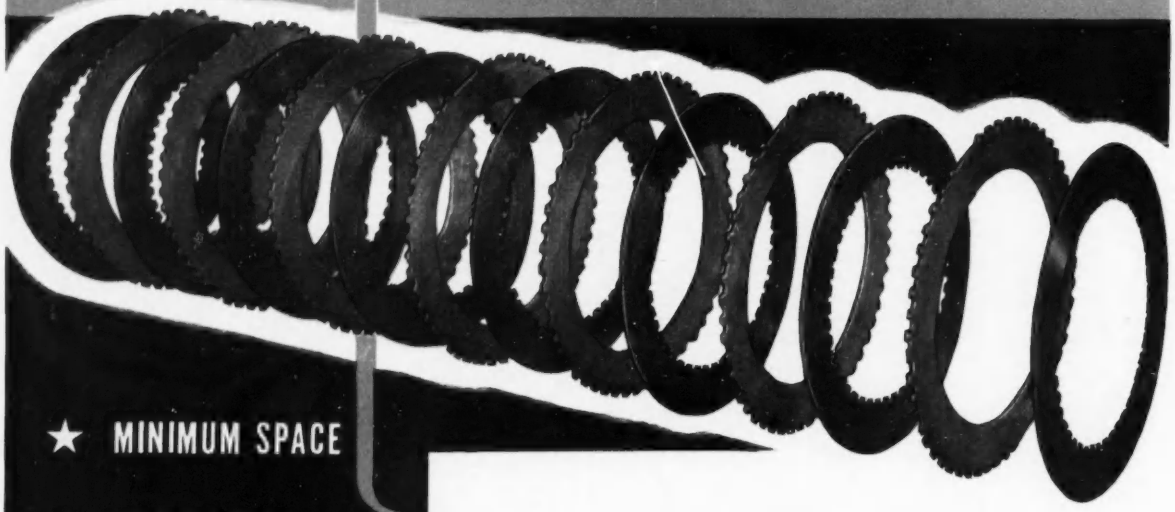

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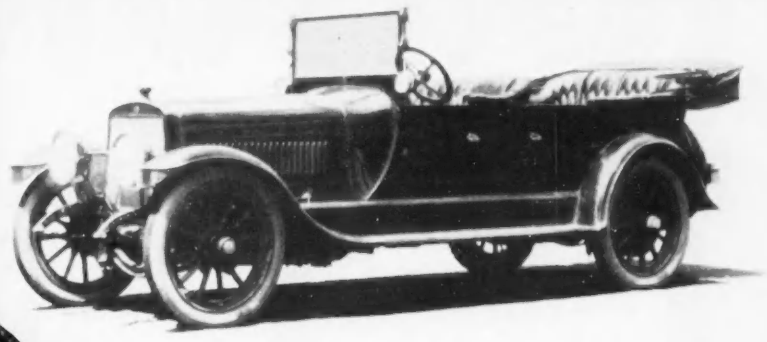
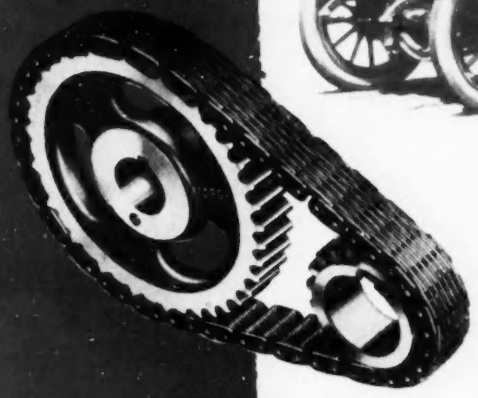
1914





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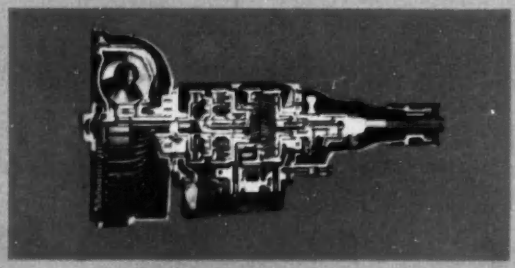

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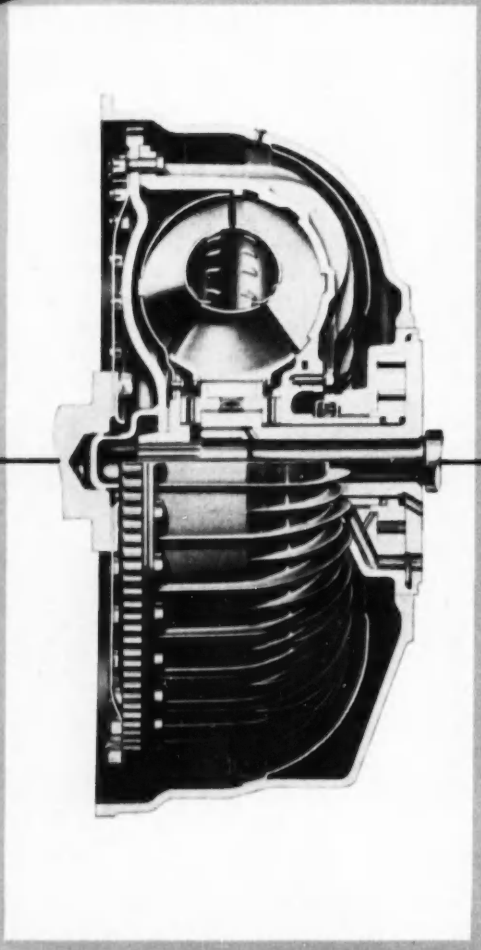

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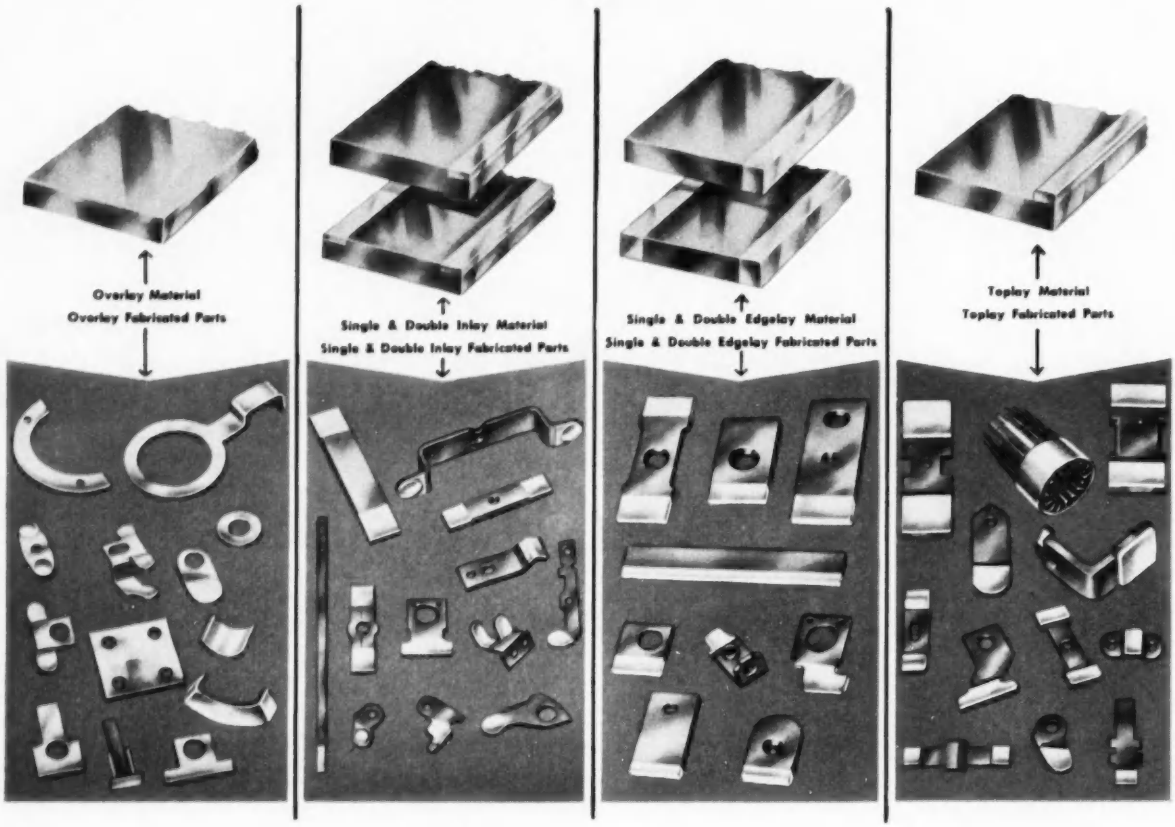
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For the Sake of Argument

More About Principles . . .

By Norman G. Shidle

"That stuff about 'Principles Can Help . . .' you had in December was OK, but you never got to the main point," we heard from a Convenient Critic shortly after December 1.

"You just proved what a help principles and patterns can be, and let it go at that. You should have told them the awful things that happen when expediency gets the upper hand . . . You've pointed the error of *my* ways plenty of times."

"You mean," we countered, "we should have told about that time you wanted to set up a product advisory committee without representation from Jack Hart's department—even though our practice calls for everybody being allowed a chance to get into that kind of an act?"

"Yes," C. C. responded, "that's a good 'for instance' —because you know darned well I not only wanted to, but did! That was the one thing that made me realize a small explosion today is better than a big one tomorrow."

Then he went on reminiscently: "That case was just one of many. Long since, I learned my lesson: Look for the principles involved before taking the action. Make any decision—however small—on a pattern you can see working soundly in the future. Don't make decisions that go counter to the principles.

"If an answer has to be 'no' eventually, better say it at once. Each action creates a precedent. Precedent hooked up with principle will win any business battle. Tied to expediency, it becomes a Frankenstein monster. . . .

"Expediency may look like a big strong fellow when you call on him for help today. But you'll find he's a weak reed when you try to lean on him tomorrow. He'll fold when you clutch for help out of the hole he shoved you into.

"Trouble feeds on expediency, starves on principles.

"When principles dominate your decisions today, tomorrow's decisions take care of themselves . . ."

C. C. began to run out of breath.

"Thanks," we said, "for our February editorial."

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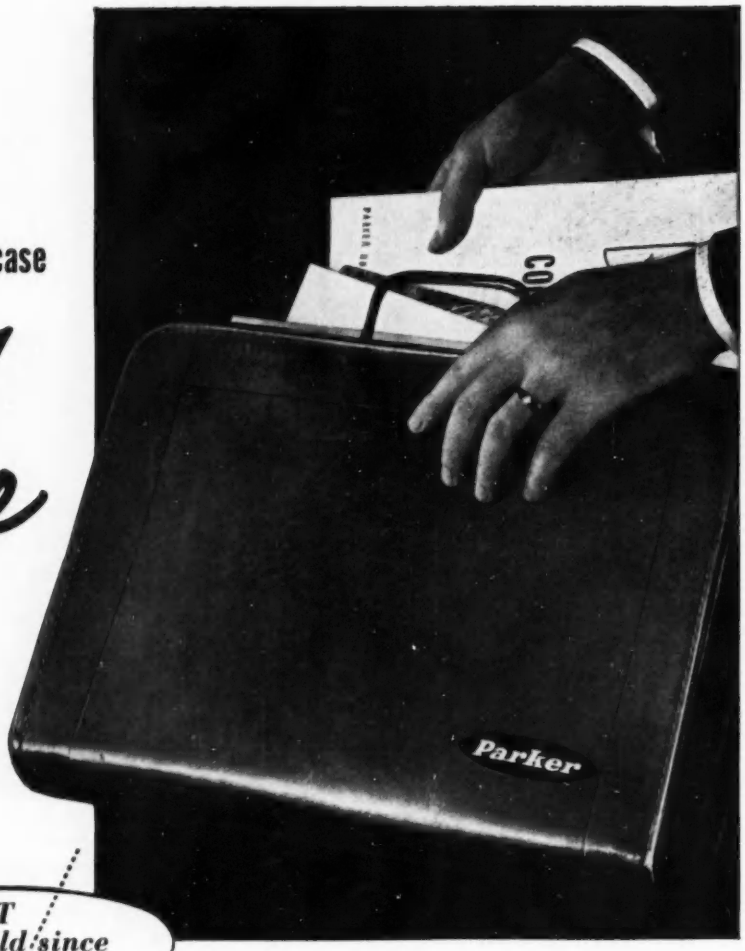
in metal surface treatment to you



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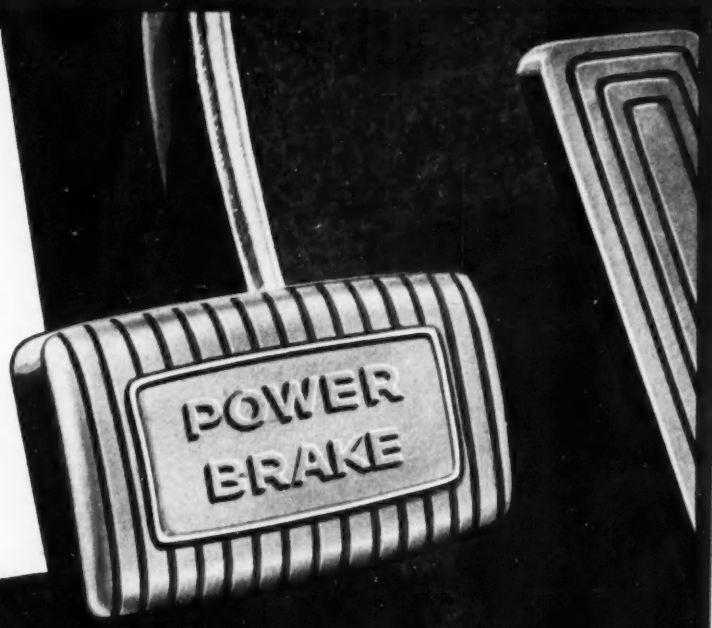

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One of the most popular new car features offered the public in years is the performance proven *low pedal* power brake engineered and manufactured by Bendix, the industry's leader in all types of braking.

The Bendix* low pedal power brake represents an entirely new conception of power braking designed specifically to meet the braking requirements of the industry's latest and finest vehicles.

This great advancement in braking is unique in many ways. It is, for example, the *only* low pedal power brake that has met the tests of millions of stops under all operating conditions. It has already won the overwhelming preference in its field with car manufacturers. And this low pedal power brake is the product of Bendix, the world's largest producer of power brakes and the originator of practically every important braking development since the earliest days of the automotive industry.

Passenger car manufacturers contemplating power braking should investigate the advantages of the Bendix low pedal power brake. *REG. U.S. PAT. OFF.

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MOST TRUSTED NAME IN BRAKING

1953 SAE Annual Meeting

. . . saw SAE in action at its best. New ideas, new facts and new ways of presenting them were featured at technical sessions.

THE week of Jan. 12, 1953 saw a dramatic example of SAE in action . . . in action at its best. The speakers at its 46th Annual Meeting brought inspiring facts and practical dreams to every one of its 22 technical sessions. Some 80 technical and administrative committees stepped ahead with projects of service to industry and plans for improved operation of the Society itself. Each day saw a new attack on what 1952 President D. P. Barnard called "problems of broad mutual interest necessary to the successful development of the industry."

Attendance at both technical sessions and the dinner once again taxed the capacities of every available meeting facility. The Engineering Display—its limited exhibit space all spoken for many months ago—was visited by a large majority of the more than 4000 members and guests who came to the technical sessions.

At the 22 technical sessions during the week, 51 papers and symposiums brought into direct action some 130 dis-

tinguished engineers as authors, panel members, chairmen, and secretaries. More than twice that number participated in the discussions following the various papers. Their comments and criticisms spotlighted the vitality and pertinency of the topics selected by the 12 Activity Committees.

New information about new engines—and the problems met in their development—tapped the attention of both ground vehicle and aircraft engineers throughout the week. The new Buick V-8, European aircooled diesels, GM's new Model 51 diesel, and special-for-helicopters powerplants were just a few of the projects highlighted in this area.

New data about new materials for both designer and manufacturing man also got serious attention throughout the week. Titanium, as usual in recent months, was the interest leader.

Technical trends in ground and air transport, future fuels, passenger car developments, and technical news from the test rooms and laboratories combined to complete the major interest areas.

At the dinner on Wednesday evening, Admiral Ben Moreell, board chairman of Jones & Laughlin Steel Corp., was the principal speaker. His topic: "Engineers—Scientific and Social." Excerpts from his forthright talk, together with other details of this outstanding event, and digests of the technical papers and discussions appear on more than 20 other pages of this issue.

turn to page 73

Gear Scoring . . .

. . . grows as problem. Formulas to express phenomenon must take more factors into consideration to become effective tool for gear design.

Based on paper by **B. W. Kelley** Caterpillar Tractor Co.

OCCASIONAL gear scoring problems were once subdued without much technical difficulty, although always with costly production changes, by modifying gear geometry by trial and error, or by changing the oil characteristics. Today, the engineer's preference for a lighter non-additive oil makes scoring a really serious problem.

Scoring is here meant a welding and tearing action resulting from metal to metal contact which removes material rapidly and continuously as long as loads, speeds, and other operating conditions remain the same. It is the type which causes noise, aggravates pitting and eventually results in complete destruction of the gear.

The phenomenon of scoring has not been adequately expressed in a formula because specific knowledge of lubrication is lacking. If the physicochemistry of lubrication were fully understood, approach to the problem would be more obvious, but the designer has had to rely on purely empirical formulas, none of which has been universally accepted because precise test data were lacking. Most formulas include some relation between pressure and sliding velocity. Use of two variables simplifies calculations but causes inaccuracy. There are seven factors considered to have significant effect on scoring resistance. These are:

1. Pressure.
2. Absolute surface velocities and resultant relative sliding velocity.
3. Oil viscosity and composition.
4. Oil bath temperature.
5. Properties of the material.
6. Surface finish.
7. Surface treatment.

All seven factors are common variables of modern gearing practice, hence a formula must take them into account to be an effective design tool.

In an analysis of scoring, a pair of gear teeth may be likened to two rollers pressing against each other at some area of contact on their periphery, rotating in such manner as to simulate the combined rolling and sliding of gear teeth. Assuming the rollers are of a known material, with known surface finish and condition, and the oil is of known viscosity and quality, three variables remain which will score the rollers, namely contact pressure, surface velocity and oil supply temperature.

Surface temperature as a result of sliding and pressure has been implied in most formulas, but it is not adequately treated and the effect of bulk oil temperature has been largely ignored. Temperature alone may be the ultimate basis for the failure of straight mineral oil. (Paper, "A New Look at the Scoring Phenomena of Gears," was presented at SAE National Tractor Meeting, Milwaukee, Sept. 11, 1952. It will be printed in full in SAE Transactions. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers).

ROBERT CASS

1953 SAE PRESIDENT

ROBERT CASS, president of SAE for 1953, majored in engineering in college and has devoted his enthusiasm and energy to engineering problems through most of his business life.

At White Motor Co., where he is now assistant to the president, he was assistant chief engineer and chief engineer from 1938 to 1945—after coming up through the engineering department there since 1925. He started his career in aeronautical engineering, as soon as he was released from the Royal Naval Air Service in World War I. He first came to the United States to teach engineering at Harvard—after studying engineering at the University of London.

(He is the fourth Englishman to be president of SAE, the sixth foreign-born.)

Cass is pre-eminent as an interpreter of engineering, a vibrant liaison between technical and non-technical people. His many talks to engineering-related audiences, his recent work as director of the Motor Vehicle Division of the National Production Authority in Washington, his proved ability to hold audience-interest at general as well as technical meetings . . . all these attest his powers to broaden technical understanding.

He has played an active part in two hot wars and one cold one.

After graduating from Crayford School in 1912, his engineering course at University of London was interrupted by World War I. He left the University to serve as a chief petty officer in the Royal Naval Air Service. A few years later he spent 2½ years in Japan as a member of a mission to the Japanese Navy. His job: to help teach the Japs how to build flying boats. His most recent contribution to the current cold war has been 18 months in Washington with the NPA.

His birthplace is London. He came to the United States to instruct in engineering at Harvard in 1924, then joined White in 1925. From 1919 to 1924, he was starting his engineering career with the aircraft manufacturing firm of Short Bros. of Rochester, Kent, England.

His assignments at White have taken him to many places, including Soviet Russia. He made one trip there in 1936–37 and another in 1938.

He has a long record of active participation in SAE activities. He was chairman of the Cleveland Section and has presented many technical papers before national and Section meetings of the Society. At the time of his election as President, he had just completed the first year of a two-year term as an SAE Councilor.

Known to everyone as "Bob", Cass is famous for his sense of humor and his enthusiasm for his work. Engineering has been a hobby as well as a vocation. A home workshop testifies to his love of construction work.

His other personal interests range over wide areas. He likes golf, is interested in literature, enjoys both opera and the theater. He is a member of the Cleveland Chamber of Commerce and Council of World Affairs.

He is married and has a son and a daughter.

COUNCILORS

R. W. Goodale

Herb Rawdon

B. B. Bachman
Treasurer

Dale Roeder
Past-President

Earle S. MacPherson

Completing the 1952-53 term as Councilors are R. W. Goodale, Standard Oil Co. of Calif., and Herb Rawdon, Beech Aircraft Corp.; also serving as a Councilor for 1953 is Earle S. MacPherson, Ford Motor Co., who was selected by the Council to fill the unexpired term of President Robert Cass. All Vice-Presidents representing Activities are members of the Council. Shown below are the three new Councilors for 1953-54, Charles A. Chayne, General Motors Corp.; W. S. Cowell, Atlas Asbestos Co., Ltd.; and J. L. S. Snead, Jr., Consolidated Freightways, Inc.

D. P. Barnard
Past-President

Charles A. Chayne

Charles A. Chayne (M '20), Vice-President of General Motors in charge of its Engineering Staff, served 21 years with Buick, 14 as Chief Engineer, before his appointment to his present position. He got his BS in mechanical engineering at M.I.T., then joined NACA as a junior mechanical engineer.

After a year with NACA in Washington and at the NACA laboratory at Langley Field, Va., he returned to M.I.T. as an instructor in mechanical engineering. In 1926 he joined Lycoming Mfg. Co. as an experimental engineer, then became a powerplant designer for Marmon Automobile Co. The collecting and restoring of antique and vintage automobiles as a hobby began in his teaching days at M.I.T. and today he has a notable collection.

W. S. Cowell

W. S. Cowell (M '36) is General Sales Manager for Atlas Asbestos Company, Ltd. He began his business career selling Lovejoy Shock Absorbers, then joined Moto-Meter Co. as a salesman, first in Canada and later in Michigan and Ohio. He became Service Engineer for Canadian Raybestos Company, Ltd., in 1927, and in 1940 became a Director and Manager of Equipment Sales and Engineering. He joined Atlas in 1947 to become Manager of its Ferodo Division, and in 1951 began his present position.

Cowell was a member of the Membership Committee of SAE Canadian Section, and when the new Montreal Section was formed in 1950, he was its first Chairman. He is Past-President of the Canadian Automotive Wholesalers' and Manufacturers' Association, and a member of the Executive Committee of the Canadian Manufacturers' Association's Automotive Parts Section and a Director of the Automotive and Aircraft Parts Manufacturers Association (Canada).

J. L. S. Snead, Jr.

J. L. S. Snead, Jr. (M '38) is Executive Vice-President of Consolidated Freightways, Inc. He has been with the company in various capacities since 1930, and has held his present position since 1949. He attended Stanford University. He is a Lieutenant-Colonel in Ordnance Reserve, and spent three years overseas during World War II on important transport assignments, first in the Persian Gulf Command and later in Europe.

Snead was SAE Vice-President for Transportation and Maintenance in 1949, and has presented a number of papers before SAE and American Trucking Associations groups. He is a member of the Board of Governors of the Regular Route Common Carrier Conference, and has been active also in the National Safety Council, the Terminal Operations Council, the Council of Safety Supervisors, and the Equipment and Maintenance Council of the American Trucking Associations.

VICE PRESIDENTS

Otto E. Kirchner—Air Transport

Otto E. Kirchner (M '41), Director of Operational Engineering for American Airlines, has been active in aeronautical engineering since he got his MS in aeronautical engineering from M.I.T. in 1924. Before that, he got a BS in electrical engineering from University of Alabama. He spent three years with NACA after graduation, then worked for Ford, and for Fairchild before joining American Airlines' predecessor company, American Airways, in 1931 as Division Engineer.

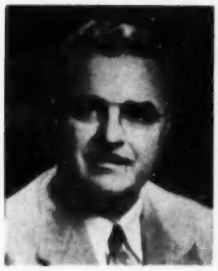
During and after World War II, Kirchner fulfilled important government assignments investigating European commercial air transport developments. In 1951, he was the airline member of the Civil Aeronautics Prototype European Survey Team investigating status of commercial air transport turbojet developments in the United Kingdom, France, Switzerland, Sweden and Holland. He is Chairman of SAE Committee S-1—Aeronautical Drafting Manual, and serves on many other SAE Committees. He is Past-Chairman of the Air Transport Association Engineering and Maintenance Conference, and is a fellow of IAS.

T. T. Neill—Aircraft

T. T. Neill (SM '27) is Chief of the Research Administration Division of the National Advisory Committee for Aeronautics. He got his BS in mechanical engineering from Catholic University in 1925, and his MS from M.I.T. the following year. After graduation he joined the Automotive Powerplants Section of the National Bureau of Standards, where he worked in the altitude laboratory on the testing of aircraft engines. He was subsequently assigned to more general engine research, and later was in direct charge of the testing of commercial engines submitted for type approval tests by the Aeronautics Branch (now the CAA).

In 1939 he became Ignition Engineer with the Air Corps at Wright Field. Just before the end of the war he joined the staff of the director of NACA, where he has been since.

E. G. Haven—Aircraft Powerplant



E. G. Haven (M '44) is Manager of General Electric Co.'s Aviation Divisions. He spent a year with the company as a student engineer after getting his BS in electrical engineering at Union College. Then, after six years with Adirondack Power & Light Co., he returned to G.E., where he worked in marine, aircraft, and industrial engineering before joining the aviation division in 1936. He became Manager of Sales in 1942, and in 1948 began his present position with sales and engineering responsibility for aircraft equipment.

In World War I he was a second lieutenant and pilot in the aviation section of the Army Signal Corps, and in World War II he served on an Air Force-sponsored technical mission to Europe to report on German aircraft advances. He has served on SAE Committee A-2—Aircraft Electrical Equipment.

Harry E. Chesebrough—Body

Harry E. Chesebrough (M '42) is Chief Body Engineer for Chrysler Corp. He got his BS in mechanical engineering from the University of Michigan in 1932, and then was enrolled in Chrysler Institute as a student engineer.

After graduation he was assigned to the mechanical laboratory, where he did development and testing on various car parts. He was next in charge of the transmission laboratory, assisting in the development of overdrive and Fluid Drive. In his next assignment, in charge of the road test laboratory, he was responsible for coordinating Chrysler's early development work on tanks. He was transferred to the DeSoto Division in 1942 in charge of engineering on the aircraft program, and served as Chief Engineer at both DeSoto and Dodge Division before being transferred to Central Engineering in the Body and Styling Sections in 1950.

VICE PRESIDENTS

J. W. Pennington—Diesel Engine

J. W. Pennington (M '43) is Executive Engineer of the Metal Products Division of Koppers Co., Inc. He received his BS in mechanical engineering at Kansas State College, where he served as chairman of the ASME student branch.

He entered the College Graduate Training Course at Caterpillar Tractor Co. in 1939, then joined Caterpillar's Research Department. He served as Laboratory Engineer, Research Engineer, and Staff Engineer in charge of the work on pistons, piston rings, cylinder liners, and bearings, and did considerable work on fuels and lubricating oils. He joined Koppers Co. in 1950 as Chief Engineer of the piston ring department, and started his present position in 1952.

Pennington belongs to ASME, ASTM and the Engineers Club of Baltimore. He was 1949-50 Chairman of SAE Central Illinois Section.

G. C. Riegel—Engineering Materials

G. C. Riegel (M '42), Chief Metallurgist for Caterpillar Tractor Co., got his BS from Central College in Fayette, Mo., then went to work in the South Works Laboratories of Illinois Steel Co. for two years. He did graduate work at University of Chicago, then worked five years as a chemist and metallurgist in the automotive industry. He joined Caterpillar in 1926, and rose from assistant to his present position of chief metallurgist in 1930.

Riegel has been Chairman of the ISTC and active on many of its divisions. He was the first Chairman of its Panel D—Tractor and Earthmoving Equipment. He has served also on committees of the American Society for Metals and the American Welding Society, and on the National Metallurgical Advisory Board as a committee member for conservation of strategic alloys.

F. A. Suess—Fuels and Lubricants

F. A. Suess (M '37) is Director of the Sales Engineering Division of Continental Oil Co. He joined the company in 1930 as Engineering Representative. He opened and operated the Detroit factory contact assignment for Continental in 1931-34, and then was made assistant to the chief technologist. He has held his present position since 1946.

Before joining Continental, he was associated with the Stutz Motor Co. as Field Service Representative in the Rocky Mountain area, western Canada, and Mexico.

Suess has served on a number of SAE Committees, among them the Fuels and Lubricants Executive Committee. He was one of a group of seven who originated and organized the SAE Tulsa Group, later the Mid-Continent Section. He has served in all the Section's elective offices.

James H. Booth—Passenger Car

James H. Booth (M '44) is Chief Engineer at the Michigan Division of Thompson Products, Inc., in charge of the Engineering Department. He has been with Thompson for eleven years, and before that spent seven years with Buick as Chassis Division Engineer in charge of Chassis Design. His first job, after attending Pennsylvania State College and Pennsylvania Night School of Business Administration, was with Duesenberg Brothers at Indianapolis.

Booth is Chairman of the SAE National Membership Committee, has been Chairman of the National Passenger Car Activity Membership Committee, and has held several elective offices in SAE Detroit Section. He has also been active on various ASME Committees.

VICE PRESIDENTS

N. P. Petersen—Production

N. P. Petersen (M '29), President of Canadian Acme Screw and Gear, Ltd., was born in Denmark and spent eight years in Rhode Island before going to Canada as Superintendent of Gillette Safety Razor Co. in Montreal. He joined National Acme Co. as Canadian Manager in 1922; in 1924, he became Works Manager with its successor, Canadian Acme. He was made General Manager in 1935 and elected President in 1941.

He is also President of John Bertram & Sons Co., Ltd., and Director of Russell Industries, Ltd.; Canada Cycle and Motor Co., Ltd.; Ferranti Electric, Ltd.; Canadian Arsenals, Ltd.; and Acme-Bertram Machine Tools, Ltd.

Petersen was an SAE Councilor in 1943–44, and is a Past-Chairman of SAE Canadian Section.

C. T. O'Harrow—Tractor and Farm Machinery

C. T. O'Harrow (M '40) is Assistant Chief Engineer of the Tractor Division of Allis-Chalmers Mfg. Co., Milwaukee, Wis. He has been associated with agricultural equipment for 25 years, 15 years of which have been spent with Allis-Chalmers working on farm tractor developments.

O'Harrow has spent considerable time, both presently and during the War, on development jobs for Army Ordnance.

He has held most of SAE Milwaukee Section's elective offices, and was Chairman of the Section in 1946.

O. A. Brouer—Transportation and Maintenance

O. A. Brouer (M '48) is head of Swift & Company's General Automotive Department. He got his degree as chemical engineer at Texas A&M in 1925, and has been with Swift since—first as assistant general foreman of adhesive products. He became successively general foreman; a member of the president's staff; and assistant head of the Automotive Department. He began his present job in 1940. He holds a patent on stationary truck refrigeration safety devices, and has collaborated with trailer and body builders in design of specialized bodies for handling perishable products.

Brouer has been Vice-Chairman of the Transportation & Maintenance Activity and National Membership Chairman, and has served SAE Chicago Section as Vice-Chairman for Transportation and Maintenance, and as Chairman for 1949–50.

N. R. Brownyer—Truck and Bus

N. R. Brownyer (M '20), Vice-President of Timken-Detroit Axle Co., is Manager of the company's Field Sales and Service Engineering Department. Before this new division was created, he was Sales Engineer and Consultant, in Cleveland and later in Detroit. Before this he was Engineer in Timken's Railway Division. Here he spent much time in Europe studying design and application of street railway equipment—an investigation important to development of the present P. C. C. streetcar truck in this country.

Brownyer's first position was with Paige-Detroit Motor Car Co.'s Engineering Department. He worked then for the G&J Truck Co. of Canada (later the Gotfredson Co. of Detroit), where he was Chief Engineer until 1926. He joined Timken-Detroit that year, and became Vice-President in 1945. He got his present assignment in 1951.

How Plastic Froth

PLASTICS have been fabricated by just about every known process . . . molding, machining, casting, extrusion, and forming. Something new has been added to the list. Plastics now are being foamed in cavities.

Lockheed is using it in structural members and calls its new plastic Lockfoam. The stuff is poured in

Where Lockfoam Has Been Used

1. Control Tab

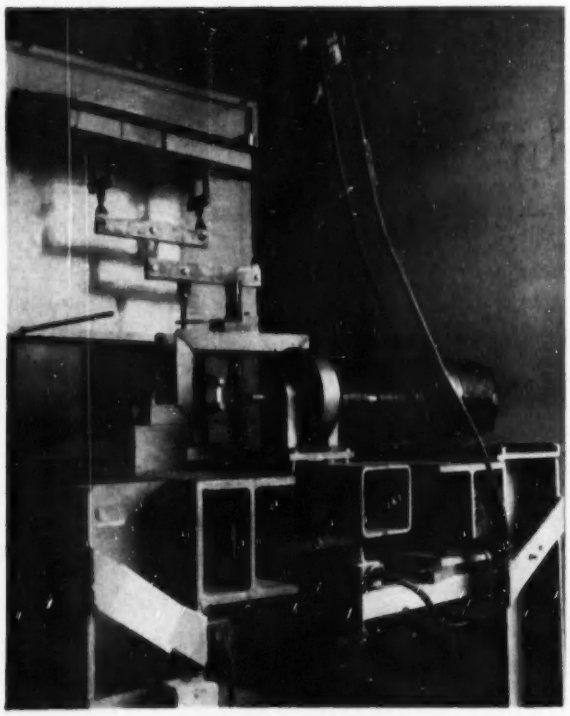


Fig. 1—Control tabs, filled with plastic foam, get a fatigue test workout

One of the first structural uses considered was a control surface tab. A tab 5 × 18 in. was chosen. Three units of equal weight were built. They were:

1. A conventional riveted structure,
2. A Lockfoam-filled structure bonded to covering, and
3. A Lockfoam-filled structure not bonded to covering.

Here is what happened to these units in fatique testing on the equipment shown in Fig. 1:

a. The conventional structure, used as a control specimen, was loaded to 4 psi, ± ½ psi, and vibrated at 850 cpm at room temperature. It failed at 300,000 cycles.

b. The Lockfoam-filled tab (bonded to the covering) was given a 300,000 cycle vibration with the same loading conditions at room temperature; 300,000 cycles at 160 F; and 300,000 cycles at −60 F. It didn't fail—even after almost one million cycles. It was then static tested at 12.5 psi. Under this condition, the upper skin buckled slightly, which allowed the foam to separate in this area.

c. The tab with no bond took 300,000 cycles at room temperature. After removing the rubber loading pad, a slight cracking could be seen in the lower surface at the leading edge.

The foam used in these tests was formulation No. 446, with a density of 8.5 lb per cu ft. The bonded foam structure was 80% stiffer than the conventional one—an important factor in high-speed aircraft.

Strengthens Plane Parts

liquid form into the cavity to be filled. Then by chemical action the liquid is made to foam—much like the "head" on a glass of beer, to fill the cavity, and solidify into a cellular structure.

Foamed plastic provides strength and rigidity in structural parts without the design complexity usually needed, Lockheed has found.

J. M. Gerschler, Engineering Laboratory, Lockheed Aircraft Corp.

Based on paper "Lockfoam Filled-in-Place Structures," presented at SAE National Aeronautic Meeting, Los Angeles, Oct. 3, 1952.

2. Radome

Our project office was given the job of furnishing a radome for the all-weather fighter, the F-94B. Flat panels made of Lockfoam were checked for radar transmission qualities and showed up well.

We then built the tooling in our shop and produced 11 domes in short order. Fig. 2 shows the tooling setup and the liquid being poured into the cavity. The fibre glass inner and outer skins follow the mold contour.

Static tests showed the design satisfactory. The radome structure also absorbed the blast from nose guns in gun fire tests. And in flight tests, radar performance proved acceptable; bore sight error was well within specified limits.

Fig. 2—Pouring liquid plastic that'll soon be turned to foam in radome

Turn page for more instances where Lockfoam has been used

Where Lockfoam Has Been Used—continued

3. Rocket Door

In one case, a rocket exit door tended to buckle from the rocket blast. This door was well designed, with a double skin combination of drop-hammered parts.

Since the hollow spaces had some depth, we thought we would at least try the foam. All we had to do was to drill four ½-in. holes and fill the cavity with fluid. The results were satisfactory and no tooling changes were required. Fig. 3 shows the revised cross-section.

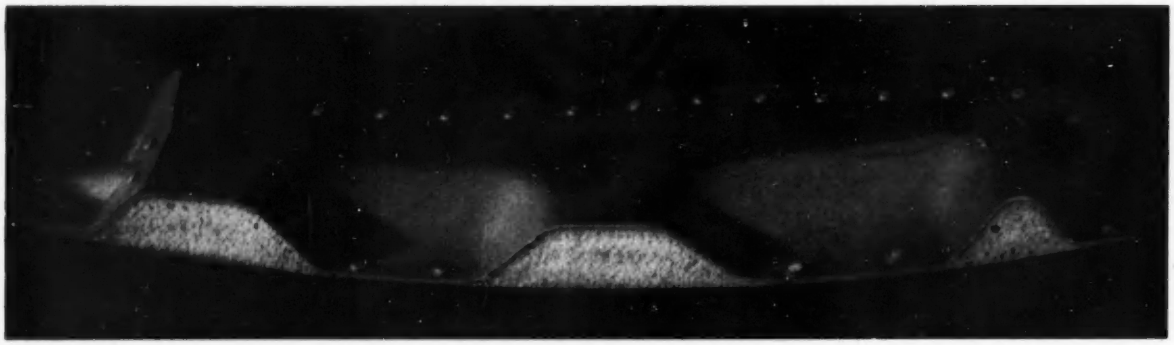


Fig. 3—Foam filler strengthened this rocket door

4. Aileron

We tackled a larger structural unit, an aileron for the latest version of our F-94 interceptor. (See Fig. 4.) Pouring liquid plastic into a larger cavity presented new problems. First we had to establish by trial-and-error the best spacing for lightning holes in the main spar. In this case, the lightning holes are used to inject the liquid.

The foam rises vertically from the trailing edge to the spar. At this point, the excess material is extruded through the lightning holes. The amount of restraint caused by hole size and spacing affects the grain structure.

Sample specimens about 2 ft long were made and restrained from bulging in wooden jogs, cross-sectioned, and inspected for grain and cell uniformity. A few trials showed the best lightning hole configuration.

In the next check, several full-scale ailerons with half spans were placed on a roof and subjected to weathering conditions. After two years of exposure, one showed no adverse effects. The other was cross-sectioned to look for signs of lamination. The bond between the skin and the foam was satisfactory. So were the results of deliberate fungus tests.

The aileron program proved that foam could be expanded in an irregular shaped cavity of fairly large size. Other shapes may take some development of pour-hole locations. But after a certain amount of know-how, this should not be too tough.

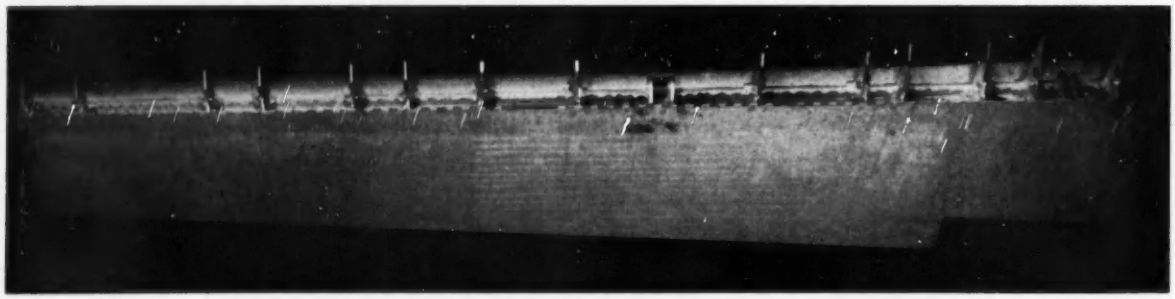


Fig. 4—It took some experimenting to learn how best to fill this aileron with Lockfoam

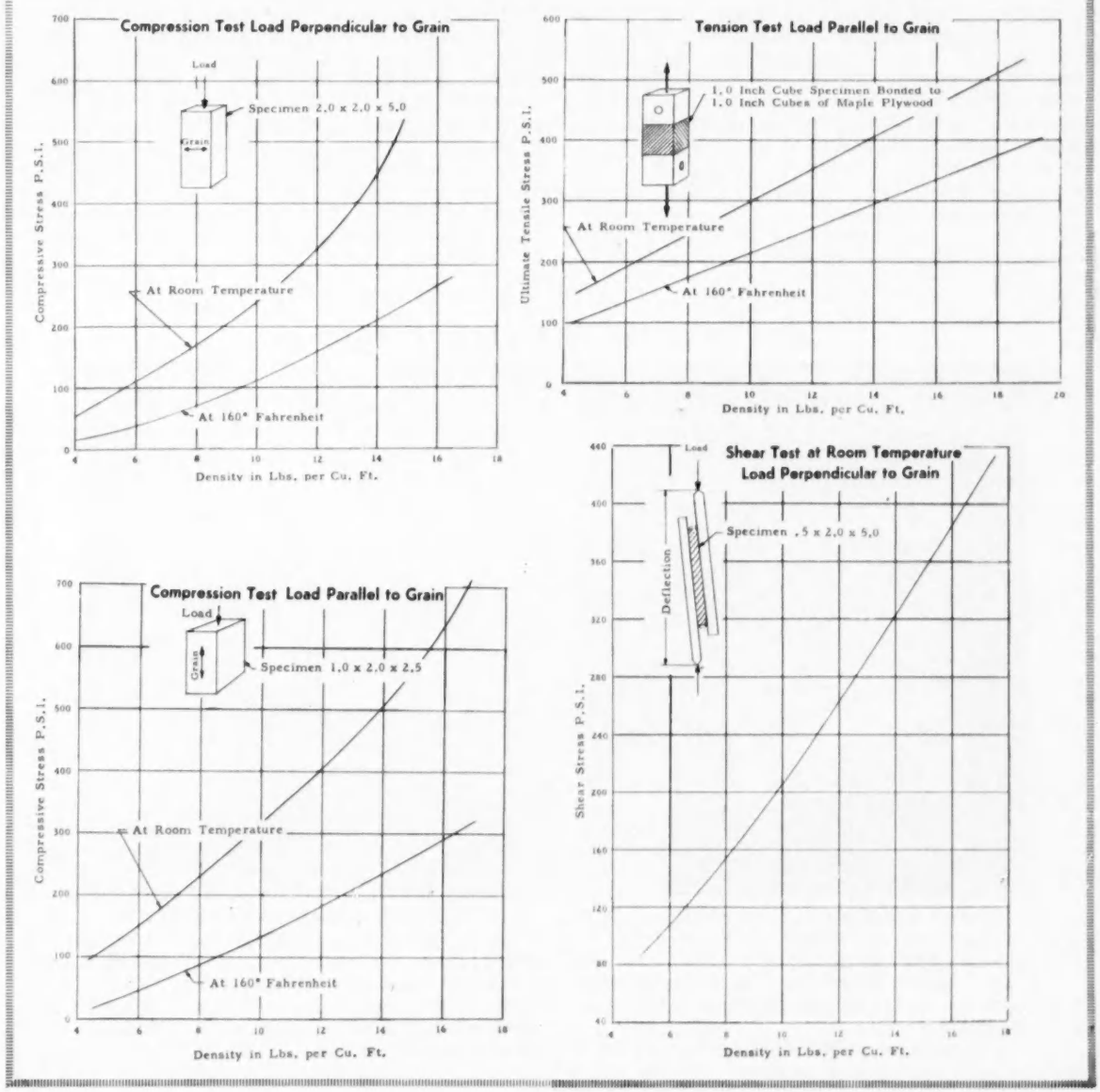
5. Other Applications

In one case we were having trouble with an antennae mast failing from fatigue. Filling the cavity with Lockfoam solved the problem. No redesign was needed.

Another case where Lockfoam proved useful was in a shockboard between the self-sealing gas tanks and the lower wing skin. Some material is needed in this location to absorb the energy caused by hydraulic ram, when a bullet passes through the wing and tank. Without such a board, the skin tends to split spanwise.

Several materials have been used for this purpose. But an evaluation by another organization showed that Lockfoam had better shock-absorbing qualities. Then too, we could specify the density. The material came through okay in wing firing qualification tests.

Physical Properties of Lockfoam


Compression Test Load Perpendicular to Grain
Load
Grain
Specimen 2.0 x 2.0 x 5.0
At Room Temperature
At 160° Fahrenheit
Compressive Stress P.S.I.
Density in Lbs. per Cu. Ft.
Tension Test Load Parallel to Grain
1.0 Inch Cube Specimen Bonded to 1.0 Inch Cubes of Maple Plywood
At Room Temperature
At 160° Fahrenheit
Ultimate Tensile Stress P.S.I.
Density in Lbs. per Cu. Ft.
Compression Test Load Parallel to Grain
Load
Grain
Specimen 1.0 x 2.0 x 2.5
At Room Temperature
At 160° Fahrenheit
Compressive Stress P.S.I.
Density in Lbs. per Cu. Ft.
Shear Test at Room Temperature
Load Perpendicular to Grain
Load
Deflection
Specimen .5 x 2.0 x 5.0
Shear Stress P.S.I.
Density in Lbs. per Cu. Ft.

Other Lockfoam Properties

Lockfoam is a cellular, gas-expanded plastic, produced by chemical reaction of isocyanates and resinous polymers. Carbon dioxide forms during the reaction and is retained as multiple cells in the compound. These cells are not interconnected. So the material has good insulation characteristics.

The material can be produced in any density ranging from 1½ to 35 lb per cu ft. Size of cavities produced for a given formulation depends largely on density, although there is some change from height of the rise.

During the foaming process, heat is generated. So considerable internal pressure is developed. For certain shapes, restraining tooling is required. In fact, in large applications, it is preferable to heat the tooling and then to cure the assembly after expansion is complete. Internal pressure helps get adhesion as well as the contour of the finished part.

The material absorbs little moisture in the densities used in aircraft applications. It's simple enough to provide a suitable seal. Lockfoam also resists aromatic solvents, engine oils, and hydraulic fluids. It can be formulated so that it does not readily support combustion.

It can be sawed, drilled, or sanded—just like wood. It also has some grain effect, although not to the same degree as wood.

In tension and compression, the effect of grain direction diminishes as the foam density increases, becoming negligible at a density of about 18 lb per cu ft. In shear, the ultimate stress with load perpendicular to the grain (parallel to 2-in. dimension of specimen) remains approximately 90% of that with the load parallel to the grain, regardless of the density.

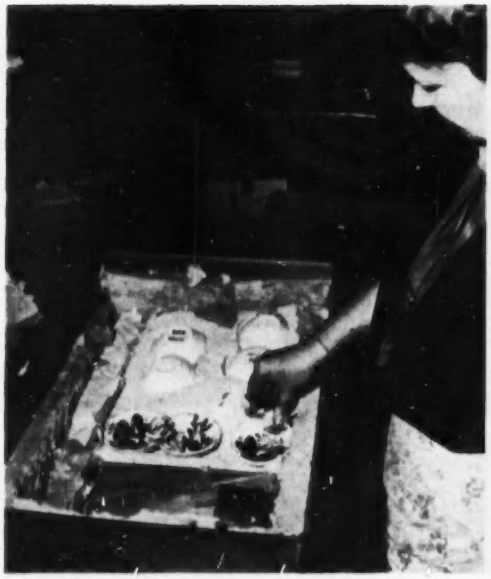
The effect of elevated temperature is much more pronounced in the compression and shear tests than in the tension tests. Typical curves of tension, compression, and shear, at room temperature and 160 F, are shown in the charts on page 27.

To get the maximum adhesion in structural applications, it's best to coat the metal surfaces with one of the Bostick cements. The zinc chromate primer normally used in aircraft assemblies permits satisfactory adhesion.

The temperature and the amount of cure is dependent on the size of the unit. In the case of the aileron, it takes 1 hr to bring the unit up to 200 F, where it is held for 2 hr.

Foam-filled structures can be repaired. Delamination between the skin and the core can be detected by tapping, preferably with a rounded fiber rod. The repair can be made by injecting some cement, such as Epon, with a hypodermic needle. The alternate method is to drill a hole in the skin, form a partial vacuum, and allow the cement to be sucked in through another hole adjacent to the area affected.

For Packages Marked "Fragile"



Another type of plastic foam, a Bakelite phenolic, has been used in commercial packaging. It cuts shipping costs because it's lighter and also does a better job in protecting breakable items, such as glassware and ceramics. (See photo above.)

This material weighs between 0.3 and 0.4 lb per cu ft. One man can easily lift a 5-ft cube, as shown above. The Bakelite phenolic foam weighs about one-tenth as much as shredded newsprint, commonly used for packing. It's got good resilience, doesn't burn readily, and its thermal insulating properties compare with those of glass and rock wool.

Combined Methods Aid Inspectors in

Determining Shot Peening Coverage

H. H. Miller and P. H. Flynn, Buick Motor Division, GMC

Excerpts from paper "Shot Peening Coverage" presented at meeting of Division XX—Shot Peening, of the SAE Iron and Steel Technical Committee, Hot Springs, Va., Sept. 25, 1952.

THE Straub and Surface Replica Methods together provide a means by which shot peening coverage can be accurately measured and easily controlled on production runs.

The Straub Method is highly accurate, although it is time consuming and requires the use of a microscope and planimeter to trace indentations. The Surface Replica Method, while one of comparison, is an excellent means of control, especially when used in conjunction with coverage standards.

A third method, Valentine's Method, has been evolved for determining coverage on parts with complex surfaces, but this method can give misleading results, comparative tests of the three methods indicate.

By applying both the Straub and Surface Replica Methods to the same shot peened area, one can determine the percent coverage and the appearance of the surface replica corresponding to that percent coverage. If there's a percentage range allowed on the coverage, say 100% to 85%, surface replicas corresponding to these figures can be made up and distributed to inspectors for use in checking production parts.

In Fig. 1 are reproduced photographs of surface replica films of various degrees of coverage used as standards to aid in the inspection for peening quality of Buick chassis coil springs.

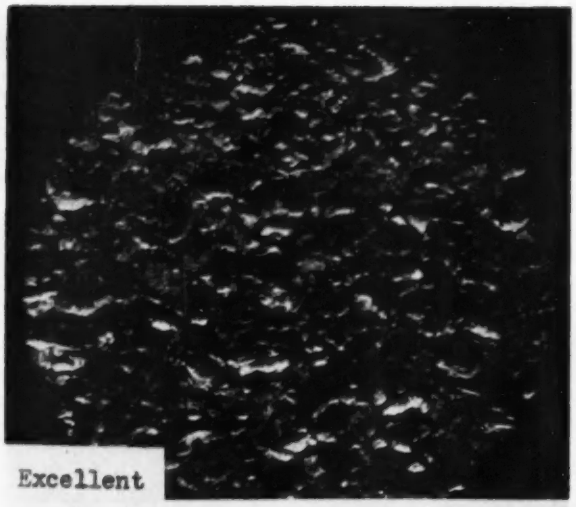
The Straub Method involves the accurate measurement of percent coverage on a polished Almen "A" strip from its magnified image on the screen of a metallurgical microscope. The image of the peened strip at 50 magnification is traced and measured with a planimeter. For accurate determination of coverage this method is the only one yet developed. It has its limitation, however, because of the fact that its application is confined to a test strip rather than to the actual peened part itself. Quite frequently the design of a part to be peened may be such that a peened strip, however carefully positioned, will not represent the peening conditions on the part itself.

The Straub Method does, of course, provide an excellent means of determining the exact peening conditions existent in a machine.

In the Surface Replica Method, after a part has been shot peened, a transparent replica of the surface is made. First solvent is applied to the area where coverage is to be measured. Next transparent film is placed over the solvent and pressed down with thumb pressure for approximately one minute. Then the film is quickly peeled from the surface. Final step is to mount the film in a holder and project it onto a screen for viewing.

It has the advantage of reproducing the condition of the peened surface on a film which may be projected on a screen for inspection. This replica need not be confined to that of a flat surface but is adaptable also to irregular contours. In viewing its projection on a screen, an experienced eye can estimate with good accuracy not only the percent coverage, but the magnified condition of the peened surface as well. The method has the added advantages of being fast, flexible, and portable—thereby lending itself to easy application at the site of any peening operation.

The third method, Valentine's Method, is used particularly for studying parts of varying cross-section or contour. In this method, a duplicate of the piece being studied is made from low-carbon steel of a specified carbon range, subjected while in the soft condition to the proposed peening cycle, and then annealed to produce a recrystallization and grain growth. The piece may then be cross-sec-



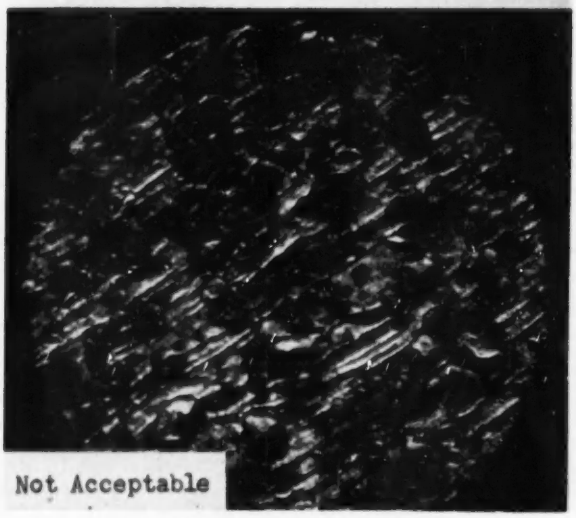


Fig. 1—Surface replica standards for Buick coil spring coverage

tioned in any plane and studied under the microscope. The extent of peening will be shown by the degree of grain growth in the various parts of the piece and will be in proportion to the intensity of the peening blast to which the area was subjected.

(The Straub, Surface Replica, and Valentine Methods are described in the SAE Shot Peening Manual.)

The three methods were compared in tests involv-

Fig. 2—Peening machine used in coverage tests

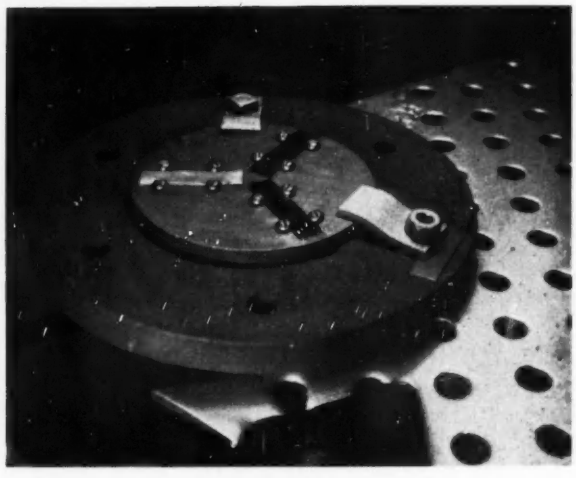


Fig. 3—Fixture for holding test strips

ing the application of various types and sizes of shot and grit. All work was carried out in a single-station rotating-table peening machine, which is illustrated in Fig. 2. The machine had a wheel speed of 1750 rpm, a wheel diameter of 17½ in., a wheel width of 2½ in., and a table speed of 40 rpm.

With the fixed wheel speed of 1750 rpm and a peening time of 30 sec., the various degrees of shot flow were controlled by orifices of ⅜, ½, ⅝, and ¾ in. diameter. The various peening media used included CW 35 and CW 54 cut wire shot, SAE 230 and SAE 330 chilled iron shot, SAE 170 cast steel shot, and G 50 grit. Peening was carried out on Standard Almen "A" strips, electropolished Standard Almen "A" strips, and normalized SAE 1008 "A" strips. The strips were mounted on a table fixture as illustrated in Fig. 3.

The procedure used in peening with each type of shot and for each orifice size was as follows:

The test strips were fastened to the table fixture, the cabinet closed, and the machine started. When the wheel reached full speed, the strips were blasted for exactly 30 sec. Then they were removed and identified. With each type of shot, coverage was varied by using the ⅜, ½, ⅝, and ¾ in. orifices. With the CW 54 cut wire, a 1 in. orifice was used also. Shot flow was measured by weighing the amount which flowed through the spout in 1 min. A sample for screen analysis was obtained from the spout at the same time.

With a table speed of 40 rpm it can be assumed that all three test strips were peened equally. The Standard Almen "A" strip was used for arc height measurement, the electropolished "A" strip for

Shot Peening Coverage Is . . .

. . . the percent of the surface struck by shot during the peening operation. That is 100% coverage would indicate that the surface, when examined after peening, would consist of overlapping shot impressions with none of the original surface remaining. And 90% coverage would indicate that 10% of the area had not been struck with shot.

Coverage in itself, does not necessarily indicate the fatigue life to be expected. This is because the primary aim in shot peening is not simply the battering of the surface, but is the induction of compressive stresses in a surface layer. The compressive stress extends beyond the shot impression into the unpeened areas surrounding it and penetrates the surface to some depth. For some parts it is possible to produce a very satisfactory fatigue life at considerably less than 100% coverage.

In general, however, to insure the best peening results and to minimize inspection problems, peening equipment should be designed to insure 100% coverage.

When the part is released for production it is frequently necessary to purchase equipment for the peening operation. To achieve the same results as were obtained on the test parts, it is necessary to secure equipment which will produce the same intensity and coverage as were present during the experimental peening.

Shot size is generally specified with intensity in mind but is also of great importance to coverage. Once machine factors have been set, changes in shot size will cause a variation in coverage. Smaller shot will give better coverage and larger shot will produce less coverage. The intensity requirements will somewhat control the variation that can be tolerated in shot size. But arc height, as measured by the Almen Strip, can be maintained with considerable variation in coverage.

Other factors such as the flow of shot, conveyor speed, shot spray pattern, and shot velocity are mechanical features of the peening operation which must be properly controlled at all times if adequate coverage is to be maintained.

Generally the inspector will observe the production part visually after the shot peening operation to determine if the coverage is satisfactory. He may use a low power glass to aid him, especially if the coverage is in the questionable category. As long as the coverage is near 100% this type of inspection is probably adequate. The part is either covered with shot impressions or it isn't. At coverages less than 100%, say 85%, it is not easy for an inspector to determine the quality of the operation. Other means such as the Straub or Surface Replica Methods must be employed.

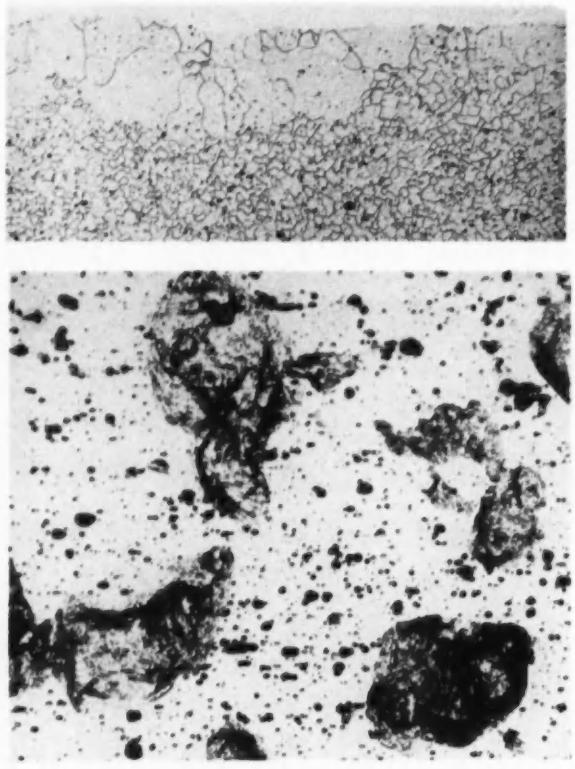


Fig. 4—Coverage in this test run measured 27.6% by the Straub Method. Cross-sectional photomicrograph shows depth of cold work in nital-etched SAE 1008 test strip for Valentine Method test at 50 magnification. Photomacrograph is of corresponding electropolished and peened Almen "A" test strip for coverage determination according to the Straub Method, also at 50 magnification. Test conditions were: 0.054-in. cut wire shot, ⅜-in. orifice size, 30 sec exposure, 5.2 lb per min shot flow, 8.0 A-2 arc height

measuring coverage by the Straub and Surface Replica Methods, and the SAE 1008 strip for determining depth of cold work due to peening according to the Valentine Method.

After peening, the SAE 1008 strips were annealed at 1300 F for ½ hr for grain coarsening, cross-sectioned, mounted in Bakelite, and examined. Photomacrographs at 50 magnifications were made of each peened electropolished "A" strip. From these the percent coverage was measured with a planimeter as prescribed by the Straub coverage method. Surface replica impressions were also made of each of the polished Straub strips.

Photomicrographs of the low-carbon strips, like those in Figs. 4, 5, and 6, showed that the depth of cold work as evidenced by grain growth becomes progressively greater with increasing coverage. However, no appreciable depth increase was noted beyond 75% or 80% coverage. It must be remembered that the depth of grain growth does not necessarily indicate the true depth of cold work. Rather, it outlines that area which has been critically stressed to within a range which, upon heating, will produce grain growth.

Therefore, it is reasonable to assume that when peening low-carbon steel, the cold work effect actually extends to a depth greater than that indicated by grain coarsening. Similarly, excessively cold worked or overpeened metal, as seen in Fig. 7, shows the presence of fine grains at the surface with underlying large grains. In this case the degree of cold work at the surface has exceeded the critical amount necessary to produce grain coarsening.

When arbitrarily used as a means of determining peening coverage, the Valentine low-carbon duplicate method could be misleading. With a few exceptions, the photomicrographs of the Valentine strips indicate continuous cold working of the surface metal, and that complete coverage was present. The corresponding Straub photomacrographs in many cases, however, show only partial coverage. The natural assumption, based on Valentine's Method, is that the cold-worked areas surrounding the shot indentations overlap, giving the impression of complete coverage when it does not actually exist.

To illustrate the cold-work effect of one shot par-

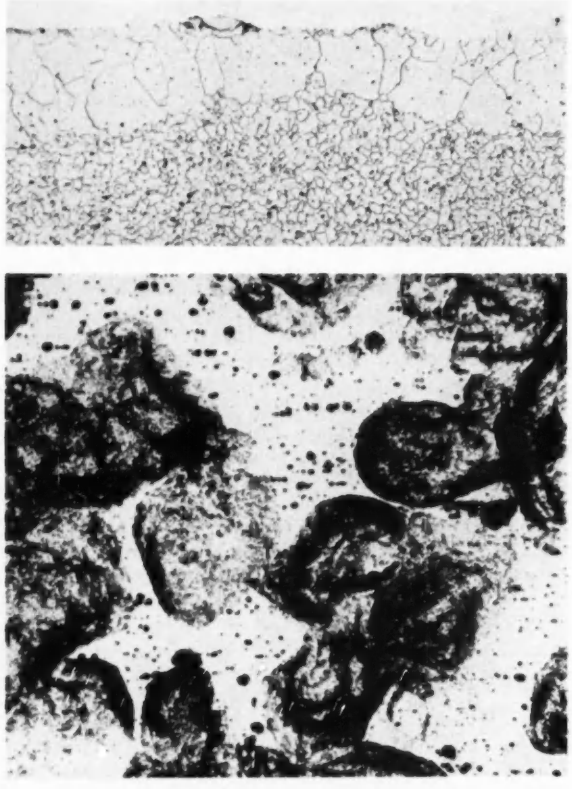
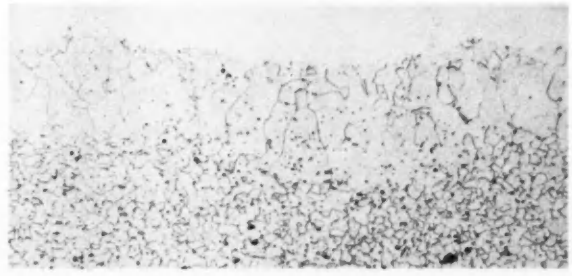
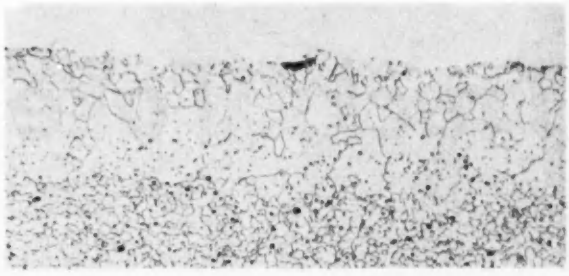


Fig. 5—Coverage in this test run measured 72.7% by the Straub Method. Cross-sectional photomicrograph taken for Valentine Method determination. Photomacrograph taken for Straub Method determination. Test conditions were: 0.054-in. cut wire shot, ½-in. orifice size, 30 sec exposure, 13.4 lb per min shot flow, 13.0 A-2 arc height





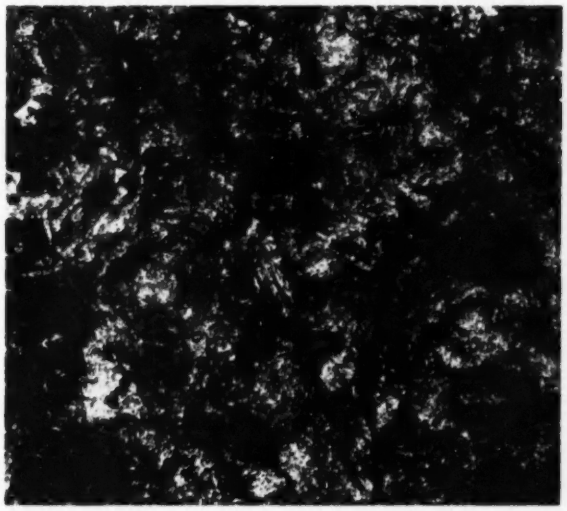


Fig. 6—Coverage in this test run measured 99+% by the Straub Method. Cross-sectional photomicrograph taken for Valentine Method determination. Photomacrograph taken for Straub Method determination. Test conditions were: 0.054-in. cut wire shot, ¾-in. orifice size, 30 sec exposure, 45.8 lb per min shot flow, 23.0 A-2 arc height

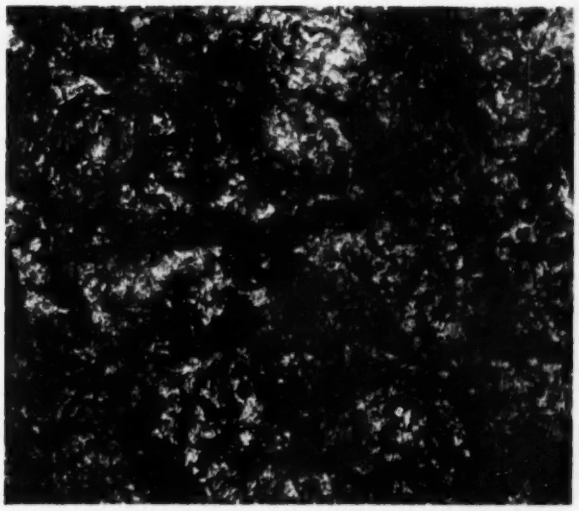


Fig. 7—Cross-sectional photomicrograph of overpeened strips show fine grains at surface and underlying large grains. Degree of cold work at surface has exceeded critical amount producing grain coarsening on heating. Photomacrograph shows corresponding Almen "A" test strip peened in same test run. Test conditions were: 0.054 in. cut wire shot, 1-in. orifice size, 30 sec exposure, 104 lb per min shot flow, 32.0 A-2 arc height

ticle, a Rockwell "B" hardness impression was made on a low-carbon Almen strip. The strip was annealed at 1300 F for ½ hr and sectioned through the indentation. From the accompanying photomicrograph, Fig. 8, it is seen that the stressed area surrounding the impression is very widespread and would overlap with that of another impression 1/32 in. or more away.

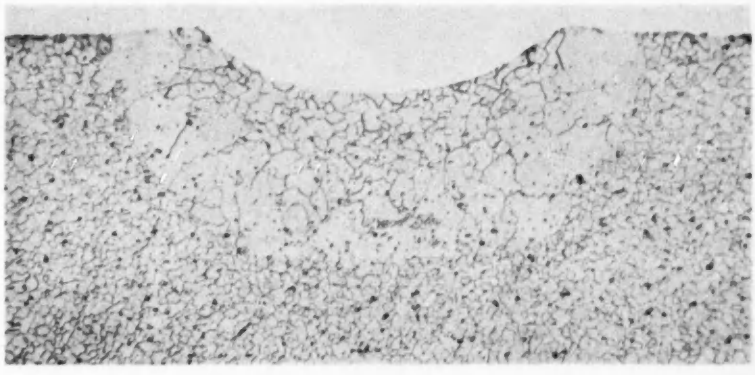
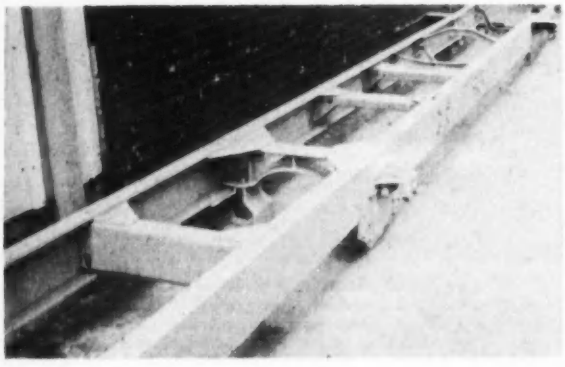


Fig. 8—Photomicrograph of cold-work effect of Rockwell B impression

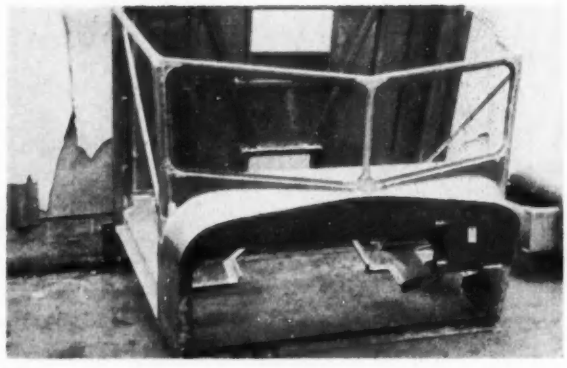
Trucks Take Off Weight:

C. L. Burton and E. P. White, Aluminum Co. of America

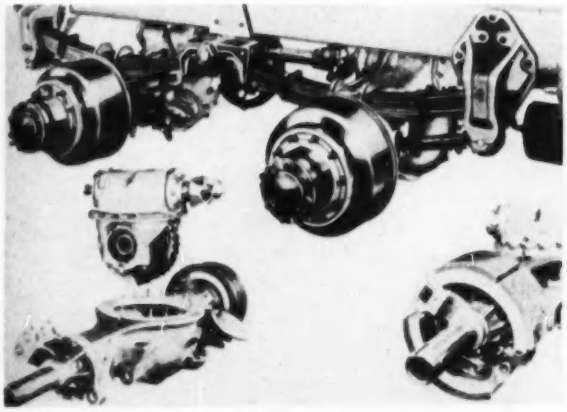
Based on paper "Lighter Trucks for Heavy Hauling" presented at SAE National Transportation Meeting, Pittsburgh, Oct. 22, 1952.



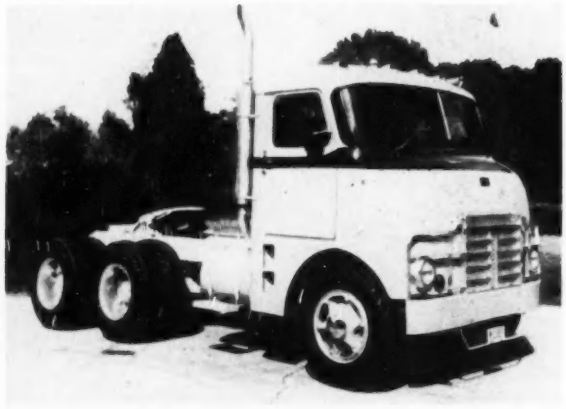
1. Frame rails and cross members made of aluminum are big weight reducers. This is true even though section thicknesses must often be increased.



2. Aluminum cabs materially reduce the dead weight that trucks and tractors have to carry. Cab construction is primarily of formed and welded sheet.



3. Tandem rear axle parts made of cast aluminum slash vehicle weight, too. Other weight-reducing sand castings include brake supports, brake shoes, hubs, spring hangers and equalizer brackets.



4. Aluminum wheels, running boards, engine parts, fuel tanks, bumpers, and hoods—all are helping manufacturers to build long-awaited lighter trucks and tractors.

Wide variety of aluminum parts knock down truck weight, boosting possible payload . . . and profits.

	Weight for Steel Construction lb	Weight for Aluminum Construction lb	Weight Saved lb
Cab:			
Frame, roof, doors, hood, dash panel, floor boards, tool, seat and battery boxes, and miscellaneous reinforcements, brackets	868	429	439
Chassis:			
Frame rails	1050	630	420
Frame cross members and gussets	519	233	286
Bumper	60	33	27
Fuel tanks and brackets	195	105	90
Air reservoir tank	27	9	18
Tandem rear axle Housings, brake spiders and shoes, differential carrier castings, hubs, and accessory brackets	1320	680	640
Spring hangers, rear frame brackets	150	80	70
Spring hangers, front	60	30	30
Disc wheels, 22 in. (10)	1150	750	400
Subtotal for chassis	4531	2550	1981
Engine and Accessories:			
Engine (672 cu in. diesel, 165 hp) Cylinder block and crankcase, cylinder heads, oil pan, flywheel housing, gear case cover	1150	515	635
Main transmission case and cover	200	90	110
Auxiliary transmission case and cover	150	70	80
Clutch housing	50	25	25
Subtotal for engine and accessories	1550	700	850
Grand Total:	6949	3679	3270

5. Altogether a weight-saving of almost 3300 lb could be realized by using various aluminum parts in present-day trucks and tractors.

Comments by Discussers . . . . . .

Use of aluminum and other light metals in fleet vehicles makes it possible to increase payload . . . and this means more profit, noted O. A. Brouer, of Swift and Co. A pound of weight saved is worth $1 a year in revenue.

Cost of making vehicles lighter must always be kept in mind, however, cautioned Mack's M. C. Horine. While it's desirable to use lighter metals wherever possible, their use invariably necessitates changes in design. And this may lead to the point where cost of reducing weight is greater than any benefits that may be derived.

Is it possible to weld and patch aluminum sheet metal, wondered L. C. Kibbee, of American Trucking Associations. And what about corrosion? . . . Yes, aluminum can be welded quite satisfactorily—and aluminum repairs cost little more than repairs to steel, replied an engineer with Brown Trailers. What's more, corrosion has not been a problem with 3000 aluminum bodies used by United Parcel Service of America, chimed in W. D. Bixby. The only time corrosion pops up is when joints have not been properly made, added author E. P. White.

Aluminum castings have been used with considerable success—but not as load-carrying members, observed Timken-Detroit's N. R. Brownyer. Much more experimental work is needed before they will be entirely reliable for carrying weight.

Still another way to reduce weight of trucks is to stop putting unnecessary gadgets on them, remarked Autocar's B. F. Jones. Such items as radiator guards and shields over gasoline tanks could well be left off.

OPERATION OF D7 TRACTOR equipped with two coolant heaters: one connected to gasoline starting engine and other connected through diesel-engine heating coil and coolant back to heater

Diesels Can Be

THE successful operation of a diesel engine in subzero weather depends mainly on the ability to get the mechanism going. Once it is running smoothly, it generates enough heat so that the low atmospheric temperature has no further effect on its operation.

This suggests one simple solution. Just keep the engine going. As a matter of fact, this is actually being done by many commercial users of tractors and other diesel-powered equipment. In some instances, the engines are not stopped long enough to get cold all winter long. This system has many advantages:

1. There is no time lost in starting the engine.
2. The heat source is inside the cylinder, where it is most effective.
3. Constant running of the engine keeps the parts sufficiently warm to avoid failure of accessories.
4. High winds, snow, and low temperatures have no effect.

If the engine cannot be kept running continuously, it may be possible to use standby heating units, which are lighted as soon as the engine is shut down. These heaters are capable of maintaining the engine—especially its lube oil and coolant—at a temperature that is sufficiently high so that the engine can be started quickly.

These heaters may be used with standby diesel-electric sets, which should be capable of starting and delivering full power in a few seconds. In the case of shovels, it may even be necessary to keep the entire enclosure above freezing temperatures to assure a quick start the following morning.

In some circumstances the standby heater or prolonged idling of the engine is not practical, because the time between jobs may be of indefinite duration. The military, in particular, requires that an engine be able to start even though cold-soaked to very low temperatures. For instance, constriction machinery may be transported great distances, arriving in naked territory in a frozen condition.

HAUCK OPEN-FLAME GASOLINE TORCH being used to start D7 tractor. Applied to intake manifold or crankcase of starting engine, this torch is an effective starting aid

Started at –65 F

D. E. Kilty, N. K. Lammers, and K. J. Fleck, Caterpillar Tractor Co.

Based on paper, "Starting Cold Diesels," presented at the SAE National Tractor Meeting, Milwaukee, Sept. 9, 1952.

For these and other reasons, it has been found desirable to develop means of starting a diesel engine from a cold-soaked condition.

These include the use of an auxiliary gasoline engine to start—and provide heat for—the diesel; combustion aids, such as ether and glow plugs; special batteries designed to operate at low temperatures; and quick-warmup heaters.

The temperature ranges through which these aids are desirable—and necessary—are shown in Table 1.

Auxiliary Engine

Below 0 F, for example, the auxiliary gasoline engine is an effective means of cranking the diesel. It provides unlimited cranking time and generates heat that can be used to warm up the diesel.

Below –25 F, special batteries are needed, if the auxiliary engine is to be started electrically.

Heaters

Below –50 F, it is necessary to supply some heat to the auxiliary if it is to be cranked by hand. One of the best heaters for this purpose is the "Hauck" gasoline torch, which is shown at the top of this page. This torch can be applied to the intake manifold or crankcase of the starting engine. It can also be used to melt packed-in snow and ice.

An application of a gasoline torch to heat a diesel

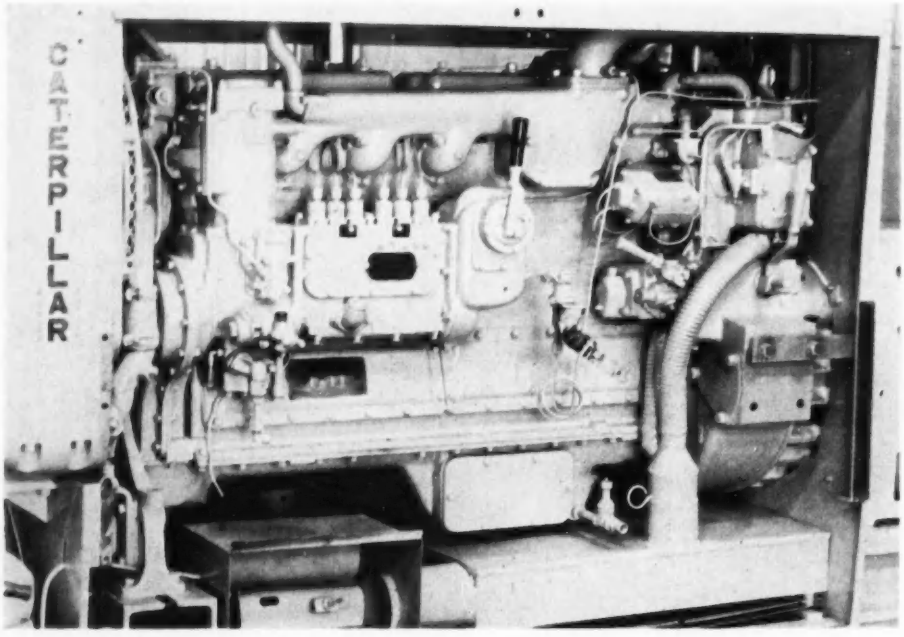


Fig. 1—Application of gasoline torch to heat a diesel engine

engine is shown in Fig. 1. It was designed to start at –65 F in 1 hr. Actually, several starts were made in 45 min following a cold-soak period of 24 hr. In this case a plenum chamber was added to mix the hot gases with fresh air to prevent possible damage from excess heat. It also served as a "stove" to radiate heat to the oil pan and fuel tank. Flexible tubes directed heat to both ends of the horizontal starting engine, and the balance of the hot gases was discharged into the engine enclosure.

Such a heater has several advantages:

1. Its lighting can be accomplished with certainty even at –65 F.

2. It is an independent heating system without batteries or external auxiliaries.

3. It does not require constant attention after it starts burning. This walk-away feature for shelter or other tasks may be important in many operations.

4. Maintenance is easy and simple. A cleaning tool or bent wire will open the large orifice if plugged.

5. The burner is a commercial item available at a reasonable cost.

6. It is possible to operate these burners on white gasoline, leaded gasoline, kerosene, or diesel fuel oil with appropriately sized orifices. White gasoline or kerosene is preferred, when available.

Combustion Aids

As shown in the table, ether and glow plugs can also be helpful in aiding the combustion of the diesel at low temperatures.

The addition of ether to the air stream of the intake manifold is effective because it lowers the autoignition temperature of the mixture. The use of ether as a starting aid became popular with the development of the pressurized metal capsule.

Fig. 2 shows the average number of 7.5-cc capsules required to start engines up to 2500 cu in. displacement. Cranking speed obviously enters into these observed values, and for this graph was the rpm obtained with the d-c starting system for the particular engine and batteries soaked to the ambient conditions of the test.

Glow plugs of the 2-v series design have been used to some extent for many years. They have not been too practical, however, because of their inability to withstand the rigors of combustion and the necessity of wiring the 2-v elements in series. The exposed element would often collect carbon and short to ground. This resulted in an overvoltage on some of the remaining plugs, leading to frequent failure. When one plug failed, all plugs became inoperative unless complicated wiring assemblies were used.

This trouble has led to the development of 12-v and 24-v plugs, such as those shown in Fig. 3. The construction of these plugs is similar in many respects to the heating element of the domestic electric range. A fine resistance wire is placed inside a tube or sheath and the entire cavity filled with magnesium oxide. The tube is then run through a die, which reduces the diameter of the sheath and compacts the magnesium oxide very tightly around the resistance wire.

One end of the wire is connected to a center terminal for the battery connection, the other is welded to the outside sheath, which is grounded to the en-

Table 1—Starting Diesel Engines in Cold Weather

Viscosity of lubricating oil used in both diesel engine and auxiliary engine (if used) should be kept below 20,000 SSU at time of starting. This can be accomplished by:

(1) Use of special oils (MIL-0-10295).
(2) Warming oil.
(3) Diluting oil.

Atmospheric Temperature	Cranking System	Combustion Aids	Heat to Engine Jacket Water	Heat to Intake Air
Down to 0 F	Electric (with standard batteries) or air motor	Ether or glow plugs necessary	Not needed	Not needed
0 F to -25 F	Auxiliary gasoline engine, cranked by hand or electrically (with standard batteries)	Not necessary	Necessary—can be obtained from auxiliary-engine jacket water	Desirable—can be obtained from auxiliary-engine exhaust
-25 F to -50 F	Auxiliary gasoline engine, cranked by hand or electrically (provided special batteries are used)	Ether is desirable for auxiliary engine	As above	As above
-50 F to -65 F	Auxiliary gasoline engine, which must first be heated by blowtorch or other means before it can be cranked by hand or electrically with special batteries. Also, use arctic gasoline	Ether is desirable for auxiliary engine and diesel engine	Heat should be applied to cranking system, diesel-engine coolant, lubricant, as well as intake air	

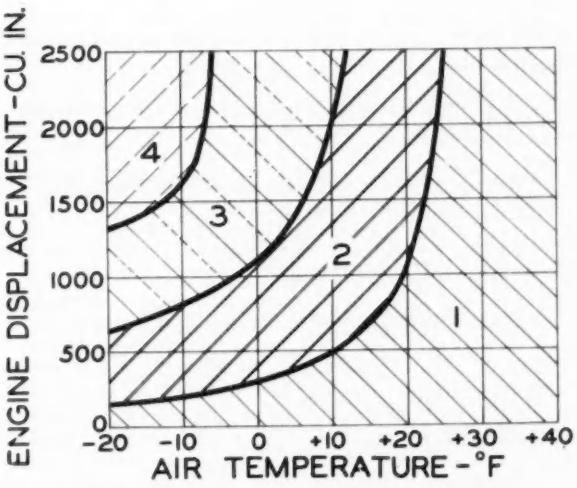


Fig. 2—Ether capsule requirement (7.5 cc of fluid)

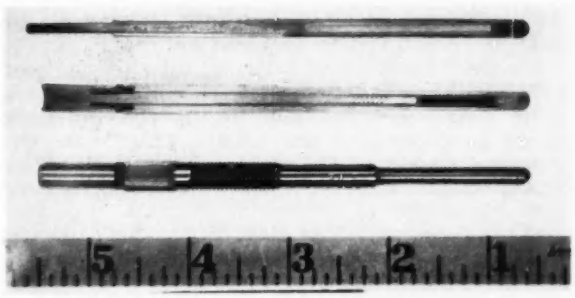


Fig. 3—Sectional views of 24- and 12-v glow plugs and view of complete 24-v plug

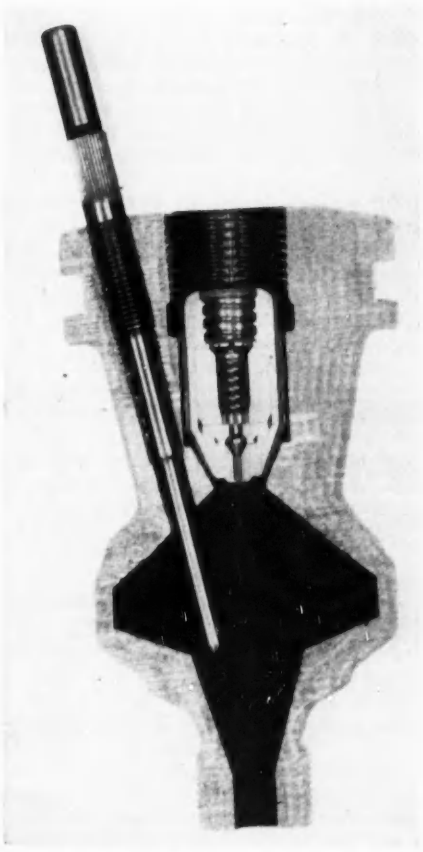


Fig. 4—Cutaway view showing typical installation of glow plug in relation to precombustion chamber and injection nozzle

gine block. The magnesium oxide acts as a support and as an electrical insulator so that the wire is insulated from the sheath; however, it is a fair heat conductor and, therefore, conducts the heat from the small wire to the sheath. Only 45 sec is required to bring the sheath up to temperature.

Fig. 4 is an example of mounting of the glow plug in a precombustion chamber. To start the engine, the glow plug is energized from the battery for 45 sec. The engine is then cranked, fuel is injected, and combustion takes place. The glow plug can be left on after the engine first fires until continued running is assured. The limiting temperature on glow-plug starts for diesel engines is largely dependent upon the limit of the cranking system, which is about 0 F when a standard battery soaked to the cold condition is used. Some engines, notably the larger bore size, will give starts down to - 15 F; however, the practical limit is considered to be near zero.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Aircraft De-Icing . . .

. . . by cyclic thermal method made more efficient with development of new heating element which permits use of higher unit intensities.

Based on paper by **B. L. Messinger** Lockheed Aircraft Corp.

CYCLIC thermal de-icing has been applied successfully to propeller blades for several years. Using resistance wires imbedded in neoprene rubber, intensities of 4 to 7 w per sq in. for energized periods of 15 to 30 sec have been achieved. However, this form of heating element is limited to about 20 w per sq in. in the intensity which can be applied.

Recently we developed an entirely new type of cyclic heating element which permitted exploring intensities ranging up to 80 w per sq in. With it, it was found that an optimum occurred at about 40 w per sq in. for an energized period of 2 sec.

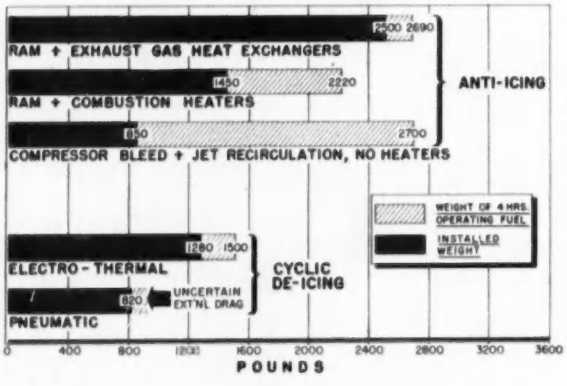


Fig. 1—Overall ice protection weight study for a typical modern turboprop transport. Charted is the installed weight of equipment and fuel chargeable to 4 hr of operation for each of five different systems. The charge includes fuel to operate the equipment (heaters, compressor bleed air, alternators, and so on) as well as fuel to overcome drag due to the system (ram air flow)

This new type of element has four other advantages over the wire and rubber combination. They are:

- Higher efficiency, that is, greater percentage of heat flowing outward.
- Smaller thermal mass, consequently a more rapid rate of temperature rise.
- Ability to produce uniformity of surface temperature at any instant.
- Aerodynamic smoothness.

Use of a high intensity for a short interval has one undesirable consequence, namely, a large number of individual segments or circuits are required to maintain a continuous and uniform power load. Compact sequence switching equipment will eventually minimize this problem. Also the intermittent nature of the load permits use of small power distribution wiring. There is the compensating advantage that only a small percentage of the total protected area is affected should one circuit or element be disabled by localized failure.

All cyclic ice removal systems suffer by contrast with anti-icing systems in one respect. There is a finite drag increment due to the ice formation which is allowed to accumulate during the de-energized period of the cycle. The magnitude of this effect has not yet been fully evaluated. (Paper, "Ice Prevention as Related to Airframe Design—1952," was presented at SAE National Aeronautic Meeting, Los Angeles, Oct. 3, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

Synthetic Lubes

Are Here to Stay . . .

. . . but they won't replace the bulk of petroleum oils. Their use, however, for such high-temperature applications as jet-engine bearings, automatic weapons, and electric motors is on the upswing.

W. A. Zisman, Naval Research Laboratory

Based on paper, "Engineering Possibilities of Synthetic Lubricants" presented at SAE National Fuels and Lubricants Meeting, Tulsa, Nov. 7, 1952. This paper will be printed in full in SAE Transactions.

JUST as synthetic fibers are not intended to entirely replace cotton or wool, so synthetic oils are not meant to replace petroleum oils. Instead, they are tailor-made for special applications where petroleum oils do not function well enough.

One area in which these tailor-made oils are finding wide application is the aeronautics field. Here they are proving invaluable for lubricating jet-engine bearings, instruments, and automatic weapons. Synthetic greases are adding substance, too, to engineers' dreams of wider operating temperature ranges and lifetime lubrication of electric motors.

Just why is it that synthetic lubricants are superior to their mineral counterparts in these and other applications?

Why Synthetic Lubes?

First and foremost, they're better because they can be tailor-made to have certain optimum properties . . . and all of these properties can be readily predicted and controlled. That's because synthetic lubricants can be made homogeneous in the chemical sense.

What's more, development of compounded synthetic oils is generally simpler. There need be no undesirable chemical impurities present to cause significant variations in performance from one production batch to another. Hence, it is possible to obtain an unusually high response to inhibitors—an example is the outstanding ability of phenothiazine to inhibit the oxidation of diesters.

These general characteristics, then, together with special individual properties, are what permit synthetic oils to do jobs that petroleum oils can't. This proved to be the case, for example, with the bearings of gas turbines.

With the advent of jet aircraft during World War II, better lubricants were soon needed to make the most of the performance capabilities of their engines. A lubricant was required that would:

1. Permit starting at subzero temperatures without dilution or use of heaters.
2. Retain enough viscosity at engine operating temperatures to support large bearing loads.
3. Be unusually stable to heat and oxidation.

In short, an oil had to be found that would give superior performance over a wide temperature range. (Temperatures frequently ranged from –65 F (or lower) to main bearing temperatures in flight of 285 F to 400 to 500 F soon after engine shutdown.) This meant that low volatility at elevated temperatures was essential, since evaporation of oil was increasing oil consumption and leaving bearings unlubricated after shutdown. Furthermore, evaporation of the less viscous and more volatile fractions in some oils increased the viscosity of the residual oil, increasing the power required for low temperature starts.

Boost Permissible Temperature

It soon became evident that such lubricants as the diesters, used alone or in mixtures with certain other synthetics, could extend greatly the temperature and altitude range of turbojets. Specifically, tests completed since 1947 have confirmed that use of aliphatic diester oils—stabilized with recommended antioxidants—result in (1) much better low and high temperature performance, (2) less hazard to fire, (3) very much lower oil consumption, and (4) ability to start at low temperatures without auxiliary aids.

Still another important application of synthetic oils and greases is the lubrication of a wide variety of aviation instruments.

During World War II, much difficulty was experienced with the gyros used for aviation and fire control. Although some of these difficulties were due to faults in maintenance and design of either the instrument or the ball bearings, many engineers believed they were often caused by the lubricants then in use. In postwar years, investigations proved that at least one source of trouble was oil evaporation at the high operating temperatures occurring in certain gyros. High-temperature-resistant oils and greases were needed . . . and tailor-made synthetic lubricants filled the bill.

One of the most interesting postwar applications of synthetic lubricants, however, has been the lubrication of such automatic weapons as aircraft cannons and machine guns. Synthetic ester oils have been found so effective in lubricating these essential mechanisms over the temperature range –70 to

150 F that they are now specified by the Navy. Diester greases have also been found ideal for lubricating the feeder mechanisms.

What's more, synthetic greases offer far better lubrication for electric motors. Wider temperature ranges and much longer storage and operating lives can be expected with the adoption of properly manufactured greases made from synthetic oils.

Indicated improvements in greases, antifriction bearings, and end-bell design of electric motors will permit approaching the engineers' goal of lifetime lubrication for equipment operating in the temperature range -65 to 250 F. And relubrication intervals with operating temperatures of 300 F can eventually be lengthened to 5000 hr . . . at 450 F to at least 1000 hr.

Use of synthetic lubricants, then, is on the upswing. Some day they will even become commonplace in the shop and home for lubrication of such familiar mechanisms as sewing machines, fans, typewriters, locks, sportsman's rifles, and fishing reels.

In the meantime, however, it should be recognized that—as with synthetic fibers and plastics—no one synthetic oil is best for all uses. Much research has been directed toward learning the proper fields of application for each of these new liquids, how to blend them, and how to modify their properties with chemical addition agents. Naturally, engineers would like to know which synthetic oil is best for each type of application or in which there exists each important property to the highest degree. However, the frequent existence of physical, chemical, and economic requirements peculiar to each lubrication problem can make it difficult to use either of these two types of general comparison. Wherever possible, each potential user or equipment designer should seek guidance from specialists about the applicability of the new synthetic lubricants to his problems.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Turbojet Cooling Systems . . .

. . . are prone to cause serious airplane performance losses. Weight and drag factors should be balanced for optimum efficiency of installation.

Based on paper by **Leonard J. Lyons** Northrop Aircraft, Inc.

THE weight of a given turbojet cooling system can almost always be decreased if a drag increase is allowed. And aerodynamicists can readily determine the weight penalty that will give the same airplane range as a given drag penalty. The ratio of weight to drag may be anywhere from two to twenty, but if the comparison is not made, airplane performance will suffer.

Internal drags, due to momentum losses in the cooling air flow, often are of considerable magnitude. A flow of 6 lb per sec, at a flight speed of 1000 ft per sec, may cause a drag almost equal to its free stream momentum of 180 lb. This is particularly true if high internal velocities are needed to secure forced convection. A system requiring only 3 instead of 6 lb per sec might easily be superior even if it weighed 500 lb more. Internal ducting design is dictated too often by space requirements, resulting in excessive pressure losses and drags. It is one thing to design a system which will supply just the flow required for cooling, but quite another to accomplish this with minimum drag.

External drag, also significant, is often given a minimum of consideration, especially in these days of unobtrusive flush inlets and outlets. The range and magnitude of the inlet and exit velocity ratios occurring with changing operating conditions must be carefully analyzed, since they are primary factors in establishing the external drags and internal pressures. The relatively large number of such holes may mean a cumulative effect on external flow much larger than the sum of their individual drags would indicate. Here, drag gains or thrust recovery must be balanced against the weight required to achieve them.

Losses in basic jet nozzle thrust due to ejectors around the nozzle are also chargeable to the cooling system. In some cases these losses are large enough to warrant discarding the ejector, although an accurate evaluation is hampered by lack of adequate data and theory for the performance of customary ejectors. Sometimes a thrust gain can be realized, and this factor must be included with the other drag elements in choosing an optimum arrangement.

Variable jet nozzle areas require variable ejector shroud dimensions to maintain ejector effectiveness. In sufficiently buried installations, a dead space results between the shroud and adjacent structure when the nozzle and shroud are closed. Normally the jet induces a low pressure in this area, resulting in a so-called "base drag," which can be a relatively large number if the pressure is low or the area large. Introducing air flow into this space can reduce the base drag and an optimum value should be found which gives a minimum sum of base, internal, and inlet drag. (Paper, "Turbojet Installation Cooling and Associated Performance Losses," was presented at SAE National Aeronautic Meeting, Los Angeles, Oct. 3, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

Cleaning the Air Is a Three-Way Job

Diesel air cleaners will make better dirt trappers if they're properly designed, installed, and maintained.

John J. Begley, Jr., Kudner Agency, Inc.

Report on Round Table on Diesel Engine Air Cleaners, held at SAE Summer Meeting, Atlantic City, June 5, 1952, under auspices of SAE Diesel Engine Activity Committee.

THREE groups must team up if air filters for diesel engines are to operate efficiently.

1. Filter designers must build into the filter both physical and performance requirements called for by equipment maker and operator.

2. Equipment manufacturers must install the filter so that the filter's efficiency isn't impaired.

3. Operators have to do a good job in maintaining, servicing, and replacing filters.

Truck, bus, and off-highway vehicle makers need at least these five qualities in an air filter:

a. Lower Intake Restriction. This will prevent loss of engine power and permit the engine to develop rated horsepower. That's because the engine will be getting the proper amount of intake air for combustion.

b. High Filter Efficiency. The filter has to take out all, or practically all, particles from the air before the air enters the engine to reduce engine wear.

c. Moderate Size. Filters available today tend to be too bulky. They have to be installed on the outside of the vehicle. This type of installation is difficult and expensive to make.

d. Effective Bath-Type Filter. There's a real need for a bath type of oil air filter, using light oil, that will not pull over into the intake manifold in hot weather, nor congeal in cold weather.

Ideally, from the point of view of the air cleaner manufacturer, the cleaner should be 100% efficient. The engine user would then have to look elsewhere for the cause of unwarranted wear. Since this ideal is impractical, compromises must be made. The exact nature of these compromises will depend on the operating principle of the air cleaner, whether oil bath, centrifugal, or panel type viscous-coated impingement. The compromise usually must take into account the allowable pressure drop, the dust concentration, and space allowances.

Another important consideration in the design of the air cleaner is its probable maintenance history in the hands of the engine user. The best of the current designs can be made to look bad by improper maintenance. Organizational and individual philosophies exist that inhibit the maintenance function as applied to air cleaners. Education and local realization of the importance of proper maintenance, not only of the air cleaner but all other auxiliary devices, will do much to cut down wear.

A Case in Point

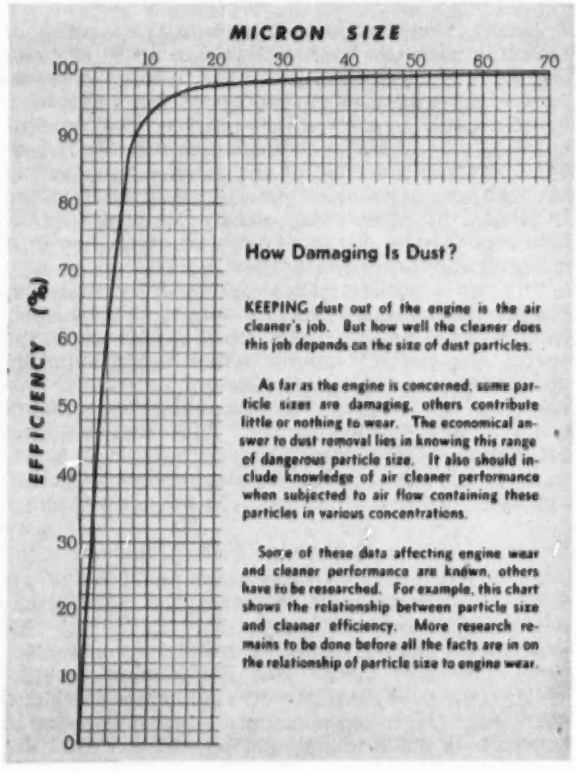
To choose one application and one type of air cleaner as an example, consider the diesel locomotive and viscous impingement filters. In this case, the air cleaner is subject to severe space limitations, vibration, rough handling during maintenance operations, variable dust concentrations, and frequently, high temperatures. Pressure drop in this case is not a serious matter since several de-

signs are available that operate within the limits set by the engine manufacturer. Maintenance can be a problem; but the railroads have been used to required maintenance, and education along these lines has usually proved effective.

Space limitation usually makes for cramped air flow passages. So adequate and experimentally checked baffles must be incorporated to assure a uniform air velocity over the face of the filter unit. Without uniform velocity, the impingement type filter operates at lower efficiency, even though the total air flow is held constant. The filter element must have a reasonable dirt holding capacity and cleanability. These properties should be so adjusted that a reasonable time—say 2500 to 7500 miles—can elapse between filter cleaning and re-oiling operations.

On the subject of service life between cleanings, it must be pointed out that the kind, amount, and distribution of the adhesives are important factors. Maintenance equipment, materials and operations must be chosen so as to apply a maximum of good adhesive, uniformly and properly distributed over the filter media. The manufacturer of the filter unit should give the necessary data to the user.

Since dust concentration on diesel locomotives is high and variable, it is the practice with many users to put car body filters on and then draw engine air through a second set of filters from inside the engine room. This double filtration is a considerable advantage.


MICRON SIZE
10
20
30
40
50
60
70
100
90
80
70
60
50
40
30
20
10
0
EFFICIENCY (%)
How Damaging Is Dust?
KEEPING dust out of the engine is the air cleaner's job. But how well the cleaner does this job depends on the size of dust particles.
As far as the engine is concerned, some particle sizes are damaging, others contribute little or nothing to wear. The economical answer to dust removal lies in knowing this range of dangerous particle size. It also should include knowledge of air cleaner performance when subjected to air flow containing these particles in various concentrations.
Some of these data affecting engine wear and cleaner performance are known, others have to be researched. For example, this chart shows the relationship between particle size and cleaner efficiency. More research remains to be done before all the facts are in on the relationship of particle size to engine wear.

One other feature sometimes desired in this application is that of sound absorption. With turbo superchargers, a good deal of 2000 to 6000 cycle sound comes out of the intake. Panel filter units are available and in use that incorporate sound baffling along with air flow baffles. A sound level reduction of from 5 to 10 decibels can be obtained in the high frequency range. Space is usually not available to reduce the level of the low frequencies by means of the necessary resonators.

Angles on Adhesives

One of the main problems in connection with impingement-type filters has been the selection of the best type of air-filter adhesive. Experiments and tests have been conducted by several firms to determine the qualities required in such an adhesive. Following are properties which an adhesive should have to perform efficiently:

a. The base material should wet dust particles and wick them through successive layers of accumulating dust.
b. Its viscosity should be minimum possible for the maximum wicking rate.
c. It should remain without loss on solid fibers of filters, without bridging between fibers, at temperatures from subzero to 200 F.
d. It should be easy to apply in controlled amounts at temperatures not above 200 F by dip, spray, centrifuge or air blast methods.
e. It should have a minimum flash point of 350 F.
f. It should be odorless and nontoxic.
g. It should be stable . . . show no separation, gelling, or hardening at 250 F in contact with air for 500 hr.
h. It should be noncorrosive.
i. It should be water resistant
j. It should be removable by hot detergent wash or steam blast.

All adhesives for impingement-type filters are a compromise between a light oil and a grease. Light oils have good wicking qualities, but won't stay on the panels. Greases stay on the panels, but have poor wicking qualities.

The oil for oil bath type air cleaners should have a viscosity which permits them to flow freely under temperatures encountered. If the oil is too heavy and congeals, filter efficiency drops off and the filter plugs up.

Although the oil should remain fluid at all times, it shouldn't be so light as to pull over into the intake manifold.

Many of the benefits derived from the air cleaner can be lost due to improper application or installation. If possible, an air cleaner should be manifold mounted. This is not always feasible; however the next closest thing to manifold mounted is an air cleaner mounted as close to the engine as possible.

Manifold application of the air cleaner insures almost 100% elimination of leak possibility between the air cleaner outlet and the engine. It also eliminates the added restriction or pressure drop obtained in piping that is used to transfer air from the air cleaner to the engine. If possible, therefore, the air cleaner should be installed as close to the engine manifold as practical.

Vehicle makers and operators told what they wanted in diesel air cleaners at a round table on the subject at SAE Summer Meeting. Members of the panel are (left to right): Secretary J. J. Begley, Jr., Kudner Agency; S. F. Duncan, Farr Co.; F. W. Kavanaugh, California Research Corp.; Ernest R. Roy, Mack Truck; Frank Torrance, Donaldson Air Cleaner Corp.; S. T. McCormick, Vortox Co.; and Chairman Hans Bohuslav, R. G. LeTourneau, Inc.

The air cleaner should not be installed close to the engine exhaust manifold. This would tend to heat the cleaner to the point where an oil loss or horsepower loss might occur. Since cool air weighs more than hot air, it is advantageous to pull the intake air from as cool a place as possible. This can add five or more horsepower to the output of the engine.

The application of the air cleaner should be such that servicing of the oil cup is not a complicated procedure, so that it can be done without interference from adjacent engine parts or accessories.

Location of the air cleaner, especially on moving vehicles, is of the utmost importance. That's because the location of the air cleaner determines to a great degree the rate of dirt pickup into the air cleaner. Because of the seriousness of the dirt pickup problem and the relation to air cleaner location on a vehicle, a considerable amount of field testing is generally conducted on this subject alone.

The rate of dirt pickup into an air cleaner, on either moving vehicles or a stationary industrial power application, can be varied and decreased by the use of proper location of the air cleaner inlet. This many times dictates the use of air inlet extensions of various heights. On equipment operating under severe dirt conditions and with all other conditions remaining equal, the amount of dirt passing through the air cleaner into the engine is directly proportional to the dirt intake to the air cleaner.

Plumbing Plays a Part

Now that we have provided a good air cleaner on the equipment and have established as well a designed air intake as possible, careful consideration should be given to the connecting pipes and joints between air cleaner and engine. It is absolutely necessary that any piping be absolutely air tight and that all joints be so designed and maintained that they are free of leaks.

Many field inspections have been brought about by complaints concerning engine failure due to dirt. It was found that in the majority of these cases that dirt has been the contributing factor to early engine failure due to leaks in the induction system between the air cleaner and the engine.

Third factor in effective air cleaner operation is maintenance. The proper servicing period of the air cleaner depends almost entirely upon operating conditions. When the job is very dusty, the cleaner should be serviced as often as every 4 to 6 hr. This period can be extended through the use of air inlet relocation or stack extensions.

The period of servicing also can be extended by experience, which will indicate the rate of dirt pickup in relation to atmospheric conditions. The accumulation of dirt in the oil cup of the air cleaner should not be allowed to rise above ½ to ¾ in. Although most air intake systems are designed so that air restriction is not excessive, a bad condition will occur if the system is not kept clean. It is, therefore, suggested that the center tube of the air cleaner, as well as any stack extensions, be inspected and cleaned regularly of any accumulations of dirt that would tend to restrict the flow of air.

The piping from the cleaner to the engine should be inspected for leaks as well as cleaned at convenient intervals. Leaks or holes should be repaired or the pipe replaced.

As a general rule, it is satisfactory to use the same viscosity of oil as used in the engine crankcase. It is important that the oil flow freely at all times. Either straight mineral oil or heavy-duty oil is satisfactory for use in air cleaners, but do not use crankcase drainings. Oil used in the air cleaner can be used over and over again through proper settling means.

At such time when the oil cup of the air cleaner is serviced, the removable section of the element also should be removed for visual inspection and serviced as necessary. In this way, trouble-free operation of the air cleaner is assured.

Servicing of air cleaners in the field varies from operator to operator. In many cases, air cleaners are actually over-serviced and a considerable amount of oil is used needlessly. On the other hand, some cleaners are under-serviced to the extent that their operation is impaired. As an example, last fall several vehicles were inspected in the field. Complaints were made on their engines. The engines in these vehicles were being prepared for their

third major overhaul. The complaint: an excessive amount of dirt in the engine.

It was found that the air cleaners on every vehicle were functioning satisfactorily, even though the removable sections in the air cleaners had not been removed for approximately 1300 hr. The only service that had been done to the air cleaners had been to the oil cup assembly, which appeared to be pretty much on a hit and miss basis.

Actually in this case, the contributing factor to engine wear was the presence of innumerable leaks in the pipe and connections between the air cleaner and engine. It can be seen that a very small amount of maintenance on this equipment would have saved several hundred dollars per vehicle that had to be placed in expensive engine overhaul. The maintenance of air cleaners has generally been worked out very carefully with the engine or vehicle manufacturer. Their instruction catalogs are devoted to this subject.

Another point that might be worth considering at this time is the periodic removal of the air cleaner from the application at least on a yearly basis for thorough cleaning. At this time, the air cleaner should be thoroughly submerged and washed in a cleaning solvent and be allowed to drain or dried out with compressed air. An air cleaner should never be steam-cleaned. The dirt material within the air cleaner is inclined to ball up when steam hits it.

There are three ways to tell when to change filters.

1. When the pressure drop across the filter is too high.
2. When the filter gains too much weight from retention of dust taken out of the air. Manufacturers will supply tables which tell when to change filters based on the gain in filter weight.
3. When the filter face has a heavy lint load.

The outward appearance of the filter is not necessarily an indication of when to change filters. However, if the filter back is dirty, it indicates that the filter has been in use about twice as long as it should have been.

Along with thorough periodic servicing of the air cleaner should go visual inspection of the element. Other musts are very careful inspection of air piping and connections between air cleaner and engine and, at least once a year, thorough cleaning of the air cleaner element. This type of air cleaner maintenance will repay itself many times and will result in more hours of operation to the engine.

Fleet Managers . . .

. . . should be handed "whole package" of vehicle selection and retirement, maintenance, and operating techniques. It's the only way job can be done right.

Based on Paper by **T. L. Preble** Tide Water Associated Oil Co.

JUST how important is the job of fleet management? Where should the responsibilities of a fleet manager begin and end? What qualifications are needed for the job? These are timely questions . . . and ones that can be answered.

Too often today top management fails to recognize and understand the intricacies and importance of fleet management. Fleet managers have no one but themselves to blame for this. Even highly competent vehicle operators can't seem to sell management on the importance of their functions.

To make matters worse, the precise scope of the whole job of fleet management has not been clearly defined in some companies. It should be made crystal clear that this scope encompasses:

- Equipment selection and retirement based on field job analysis and thorough cost accounting studies.
- Maintenance that brings reliable and economical operation.
- Vehicle operating techniques designed to reduce both out-of-pocket and investment outlay.

This, then, is the whole package . . . and it must be handed to the right man. He, in turn, must be given authority commensurate with his responsibility.

Now what are the management qualifications for such a fleet executive? Thomas H. Nelson, of the firm of Rogers, Slade, and Hill, answered this question in part when he said:

"Today 50% or more of the specifications (of a manager) have to do with ability to plan, organize, build morale and teamwork, establish good public relations, and build for continuity—matters beyond his technical specifications. . . . Ability to get results through others. . . . Think in terms of functions rather than merely in terms of specific operations and specific methods. . . ."

Genuine executive ability, then, is a management "must" in any fleet operator. But so is technical training. The value of a man charged with fleet management is of course greatly enhanced by his ability to understand intimately the complicated, expensive equipment which he commands. Specifically, a fleet manager:

1. Must be thoroughly proficient and precise in coming to conclusions as to minimum field operating requirements.

2. Must be capable of making staff studies of a multitude of problems, including maintenance re-

search, unusual designs to fill particular cases, diesel versus gasoline power, and so forth.

3. Need not be qualified to specify the proper physical, chemical, and design characteristics of component parts, but he should understand thoroughly the fundamentals of overall vehicle design.

4. Need not be a qualified fuels and lubricants man, but he should be basically grounded in this complex subject.

(Paper, "Fleet Management: A Job Evaluation," was presented at SAE National Transportation Meeting, Pittsburgh, Oct. 22, 1952, and at SAE Metropolitan Section Meeting, Dec. 11, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers. It will be published in full in the 1953 SAE Transactions.)

Closing the Gap . . .

. . . between aircraft and terminal cuts turn-around time at Avianca's Baranquilla, Columbia, airport. Ten months trial proves efficiency of Loadair system.

Based on paper by **H. W. Anderson** Whiting Corp.

BRINGING the threshold of the aircraft to the threshold of the loading dock by means of a system known as Loadair has enabled Avianca to reduce its average turn-around time approximately 40 minutes, which is 50% of the best previous average performance. At the Soledad Airport in Baranquilla, Colombia, S. A., an aircraft on arriving is taxied onto the Loadair cars and is carried sideways to the dock—a simple push-button operation. Passengers can then disembark or embark under cover, while commodities are moved between plane and dock by conveyors.

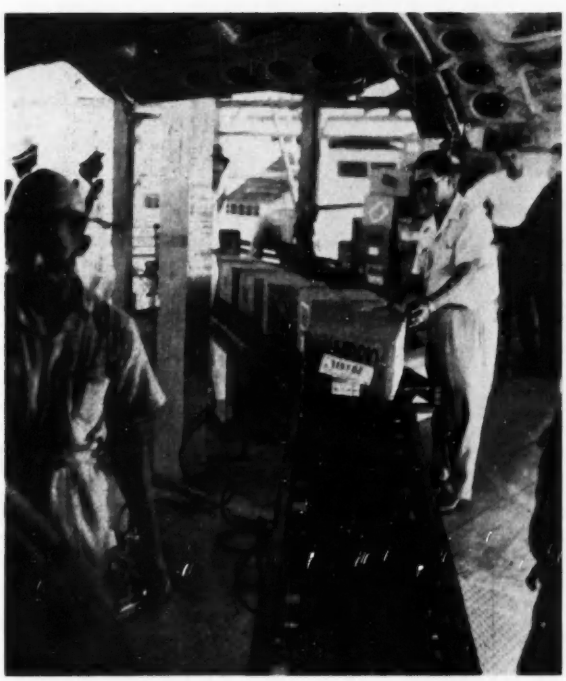


Fig. 1—View from inside of a C-46 showing cargo being removed by Loadair system in Colombia, S. A. Cargo, which may range from felt hats to milling machines, is protected from the elements and from pilferage

In contrast to the frenzied cycle of cargo movement at the average airport, at Baranquilla a standard conveyor set-up and a monorail have replaced the need for numerous pieces of equipment and the cycle of operation is materially altered. Off-coming cargo does not have to be lowered at the aircraft door. The distance between plane and warehouse does not have to be travelled repeatedly and cargo is not transferred from one handling device to another. Other advantages are the ease of parking as contrasted with taxiing in close quarters, and the reduction in pilferage.

Although there are savings in the operation of the Loadair system they do not show up as prominently as they might due to the low wage scale for common labor in Colombia and other South American countries. The cost of machinery compares very favorably with the cost of current mobile and portable loading equipment. The economies in ramp area can produce savings in paving equal to or greater than the Loadair cost because space for maneuvering and for wing tip clearance is eliminated. Furthermore, three planes can be positioned safely in terminal building areas which would only accommodate two under conventional practice. Electric motors require little maintenance and the cost of current used is nothing in comparison with the cost of fuel, tires, oil, repair and overhaul of the mobile equipment used previously, to which must be added the salaries of the chauffeurs and operators.

(Paper, "Results of Loadair Operation in South America," was presented at SAE National Aeronautic Meeting, Los Angeles, Oct. 3, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers).

Gears . . .

Common-Sense Answers to Everyday Questions

O. W. Barker, Chief Engineer, Kearney & Trecker Corp.

Report on Panel on Gears at SAE Production Forum, Milwaukee, Sept. 8, 1952.

Speed

Question: What is the recommended maximum velocity in feet per minute for operation of gears?

Answer: There does not seem to be any hard and fast rule that can be applied to this problem. One company operates a 36-in. diameter spiral gear and 9-in. pinion at 6000 fpm, while in a certain tractor application, a speed about 3800 fpm was found objectionable due to noise. The maximum speed at which gears may be operated depends on a number of factors, such as the accuracy of the gears and the mounting of the gears. Modification of the gear tooth form is very important, sometimes more so than the accuracy of the gear itself.

Sometimes greater noise in a gear set will occur at no load than when the gears are operating under load. One of the reasons high speed gears are apt to be noisy is that the loads at high speeds are usually much lighter than for gears operating at low speeds.

Standards

Question: Would it be better to set up functional standards or dimensional standards for gear inspection?

Answer: While functional standards are valuable in the inspection of gears, dimensional tolerances must be given to the shop for manufacturing purposes. The tolerances of gears depend of course upon their application. For inspection purposes, gears can be classified according to speed and torque. Gears also might be classified according to the manufacturing operations necessary to meet certain tolerances. Rolling gears with masters and matching of gears is an important method of inspection. But perfect gears, such as masters, are not necessarily an indication of noiseless gear operation.

Crowning

Question: What is considered good practice in the crowning of gears?

Answer: A gear should not be crowned more than necessary to obtain a good bearing for the

Concluded at bottom of page 50

Members of the Gear Panel are taking in some information from the floor. These men are (left to right): Secretary O. W. Barker, Kearney & Trecker; J. C. Straub, American Wheelabrator and Equipment; Fred Bohle, Illinois Tool Works; N. T. Nilson, International Harvester; Leader B. W. Keese, Wisconsin Axle Division, Timken-Detroit Axle; C. Staub, Michigan Tool; Igor Kamlukin, Allis-Chalmers; A. S. Black, Fellows Gear Shaper; L. A. Bixby, management and engineering consultant; and F. L. Knowles, Gleason Works

. . . Heat Treating

Clear Up Design and Manufacturing Problems

R. M. Ulichney, Ladish Co.

Report on Panel on Heat Treating at SAE Production Forum, Milwaukee, Sept. 8, 1952.

Normalizing

Question: How should 94B17 steel be normalized for machining, and what hardnesses are expected?

Answer: Trouble can be anticipated with these grades of steel if they are treated in furnaces, which were designed for the higher alloys where the cooling rates of the last zones are necessarily slow. Furnaces which normally gave hardness results of 163 BHN on the higher alloys are now producing hardnesses of 121 BHN on the 94B17. The better treatment would be a still air cool from a normalize temperature.

Where the furnaces do not lend themselves to this type of treatment, it has been found that varying the thermal cycles, by dropping the third zone from 1200 F to 1000 F and then cooling to 600 F, gave good results. Allowing the third zone to coast at 1475 F also produces good results, since that breaks up the pearlitic colonies and allows for better broaching operations.

One user finds that machining in the "as forged" condition has given very satisfactory tool life and machining conditions even over and above the normalize operation. He gets better chip formation with the "as forged" structure and is not especially concerned with the hardness resulting from this operation. Furthermore, there was no greater distortion other than that which is normal with a given design and quench procedure.

The distortion is a further problem in the quenching operation of the boron grades; special quenching techniques must be taken to prevent the distortion. There has been little uniformity from heat to heat and it is generally agreed that these grades must be piloted 100%.

Forgings

Question: What is the hardness variation in the "as forged" condition and how is the cooling controlled from the hammer?

Answer: Random checks have shown a hardness variation of 190 to 217 BHN, which is not as much variation as is commonly thought to exist.

Question: Have there been any repercussions in the final treatment when machining these pieces "as forged?"

Answer: Not any more than when normal care is taken in watching the broaches and design

Questions on heat treating answered by this panel of specialists ran the gamut from austenite concentration to temperature zones in furnaces. Men on the panel are (left to right): Secretary R. M. Ulichney, Ladish Co.; L. W. Steege, John Deere Waterloo Tractor Works; T. A. Frischman, Eaton Mfg. Co.; L. E. Webb, Clark Equipment; Leader J. E. Schoen, Marquette University; J. H. Clark, International Harvester; C. I. Wesley, Wesley Heat Treating Co.; and W. Holcroft, Holcroft and Co.

to provide for satisfactory results in the final heat treatment.

Question: In machining of "as forged" material, does the same improvement exist in all phases, such as shaving and hobbing as well as turning?

Answer: There has been no trouble with any of the other operations and the same general improvement was noted.

Carbon Content

Question: If a higher carbon core makes for better machining, why not add the carbon and use a 94B20 instead of 94B17?

Answer: 94B20 gives core hardnesses in the neighborhood of 41 to 50 Rockwell "C" versus 35 to 38 Rockwell "C" on 94B17, giving rise to excessive distortion.

Question: Have results been similar to 94B17 when using the 50B and 51B series?

Answer: Distortion was very bad at first. But this was to be expected since there would be a change in distortion pattern wherever there is a steel change, regardless of whether the new type introduced is a boron steel or not. After machining, changes were made in the operation, the results were satisfactory.

When gears of this analysis were martempered, there was no distortion evident at all. The machinability noted on this grade was not as good as the 8600 series used previously, but did not show a very great drop-off. The point has been reached, in the one user's operations, where a 50B series is interchangeable with the 8600 series; but there are greater problems with high core hardnesses in very thin sections.

From the commercial heat treater's viewpoint, where cycles are set up and are giving satisfactory results, they should not be interfered with on the basis of production requirements. Variation in cycle through the use of different furnaces, because of production requirement, very often causes inferior results.

Question: Is it not better to have a slight amount of retained austenite in the gear for better "wearing in" properties of the gear? In that way the slight hills and valleys in the gear face should better be able to adjust themselves with softer constituents.

Answer: It is easier to break in a gear with a slight amount of excess austenite. However, the austenite must be very carefully controlled, which is a difficult operation. This austenite must be confined to the surface, instead of mixed throughout the case.

The austenite might act as a cushion for the martensite present, making for a better breaking in operation. However, running austenite too high—in the neighborhood of 20%—has been known to give rippling and subsequent failure of the gear.

Gears . . . continued from page 48

particular application in which it is used. Very often excessive crowning is used to correct errors in mounting, such as misalignment of shafts, poor bearings, or excessive shaft deflections.

Question: How much should a gear be crowned per inch of face width?

Answer: The practice is from a few tenths of a thousandth to four or five thousandths. The limit of crowning of course is controlled by the clearance necessary for the teeth of the crowning cutter.

Surface Finish

Question: What is the importance of the finish on the face of gear teeth from the standpoint of lubrication and scuffing?

Answer: It has been found from experience that a microinch finish of from 25 to 30 is often better than a very fine finish in the neighborhood of 5 microinches. However, microinch specifications for the finish of gear profiles are not in general use.

Question: What is the influence of grinding or shot peening to pitting of gears?

Answer: It has been the experience that shot peening does not materially influence pitting of gears. The resistance of the pitting of gears is increased by increasing the pressure angles. This is in accordance with the Hertz theory of stresses produced by the pressure of one cylinder upon another.

Question: If the surface carbon on the carburized gears drops to 0.80%, what is the relation of this carbon content to the wear of the gear?

Answer: The automotive people may have data on these tests, but no data can be cited at present. The 0.80C seems a little low; however, it is known that the impact strength of the case is raised as the carbon content of the surface is lowered.

One user feels that the low carbon was satisfactory for most operations. The carbon content should be under 1%. Another user cites an experience where carburizing was overdone and the excess austenite in the case caused spalling. He feels the case should be fully martensitic rather than have retained austenite.

Distortion

Question: Is distortion associated with the character of the case or the hardenability of the core?

Answer: It has been conclusively demonstrated that high core hardness gives distortion; however, it has not been possible to divorce the function of the case entirely from this action.

One user says the case has a definite effect. In actual operation, when he cleaned his carburizing furnace and changed carbon potential, he had greater distortion with a case not quite as deep. This may have been due to the change in lapping conditions, but it would be difficult to ascribe this change to the core only.

Question: There have been references that the distortion in the bar of steel is due to the high Ms temperatures of these grades of steels and if this is dropped, the problem is eliminated.

Answer: This points to the fact that changes in treating procedures are necessary and may call for modifications such as hot quenching. If the Ms is exceedingly high, the material should be martempered and the case carbon kept under 1%, to get away from carbide formation in the case.

Grinding Cracks

Question: What is the effect of carbon concentration versus grinding cracks subsequent to heat treating?

Answer: One user tells of an experience wherein he was unable to relieve grinding trouble despite many changes in types of wheels and grinding procedures. Finally the treating procedure was changed to carburizing for 2 hr at 1600 F and drawing at 425 F.

Grinding cracks were eliminated entirely, the 1600 F temperature, of course, reducing the carbon potential. Tests also were conducted to show that the elimination of the cracks were not a function of the draw temperature.

Double carburizing operations very often cause grinding cracks and at times may cause quench cracks.

Pitting

Question: What is the comparison between austenite concentration and pitting?

Answer: If operation is proceeding satisfactorily under a given set of conditions and then pitting subsequently occurs, it can usually be associated with excess austenite in the case. However, this is not always thought to be true, since it depends on individual loading and concentrated stresses.

The amount of residual austenite and its relation to pitting depends upon the application. In roller bearings, it has been found that they cannot tolerate any austenite at all. In spiral bevel gears, where there is some sliding friction, they can tolerate some retained austenite. In the hypoid gear they must have 100% martensite; in transmission gears, the amount of retained austenite doesn't make much difference.

As for the causes of pitting, a survey of 15 sources showed very little agreement as to the cause of pitting. Experimental work had been conducted which indicated to one source that the pitting is a function of compression fatigue.

Gas Carburizing

Question: In gas carburizing operations, what should the temperature before the quench be?

Answer: The last zone should be dropped from 1700 F to 1550-1650 F, with more of the users favoring the lower temperature wherever possible. This procedure helps prevent skin decarburization and also controls the residual austenite. Care must be taken that the furnace is dropped no lower than 1500 F because there is danger of ferrite precipitation and possible duplex structure.

The problem of skin decarburization may go so far as to require in the future that highly stressed gears such as hypoids have an enclosed quench in order to reduce this decarburization.

Straightening

Question: How should shafting be straightened?

Answer: One user pointed out that he had been unable to straighten carburized and double quenched shafts with distortions of 0.005 to 0.015 in. by press straightening due to inability to straighten cracking, and flame straightening gave soft spots. He was able to get out of dif-

ficulty by quenching from 1380 F, at which time the shafts straightened very easily.

There are hazards in this operation. Where a 1380 F quench was used on a seven-pitch gear, core hardness dropped to 8 Rockwell "C". The case transformed simultaneous to, or ahead of, the core, and fatigue cracks were present due to residual tensile stress.

Cold straightening of carburized shafts may be performed satisfactorily, but may give subsequent trouble in service. They must finally be tested in the field before it can be said that it can be satisfactorily accomplished.

The application of cold straightening depends on the type of part being straightened. Camshafts will normally be cold straightened but one user will not straighten any spiders. The analysis also has the effect one user will not straighten 6120 steel due to presence of chromium carbides.

Question: How much distortion can be removed on a given carburized shaft?

Answer: Some cases have been noted where distortions of 0.020 to 0.030 in. have been removed by straightening at 300 F.

One user reported considerable difficulty with straightening and quenching an 18-in. shaft with a 12-in. keyway with a hole drilled in close proximity to the keyway. He had used a salt bath carburizing and mar quenching, but still experienced difficulty. The problem was finally solved by variation in the heating and quenching in still oil.

The problem was largely one of protecting the keyway and the drilled hole from subsequent carburizing throughout the section adjacent to the keyway and hole.

Question: On single keyways, can "bell mouthing" to the extent of 0.001 to 0.003 in. be eliminated in the carburizing operation?

Answer: There does not seem to be a ready or easy solution to this condition. Normal procedure is to use the shafts in this condition. It has been found that this condition has been lessened by a mar quenching operation but it is still nevertheless present.

One solution may be to cut the keyway after the carburizing operation, or use clay to prevent carburization. A better solution would be to machine compensating distortion into the keyway and subsequent distortion will cause the keyway to be within tolerance.

. . . more about Gears and Heat Treating

Normalizing

Question: It has been noted in gear cutting operations that gears which were normalized at the beginning of the week's production gave difficulty holding tooth form in subsequent operations. What would cause this condition?

Answer: Furnace cycles must be changed according to varying conditions, especially where atmosphere furnaces are used. Therefore, the schedule should be changed at the start of the week to overcome differences such as soaking of the furnace, actual temperature and time at temperature.

Question: Why would this variation be noted in the straight normalizing operation?

Answer: The location of the furnace with possible drafts may cause some air hardening and variations in ambient temperature or stacking may give rise to changes.

When an actual test had been run to determine the effect of variation in the heat-treating operations, one heat was split into three groups of 50 gears each, one group being normalized, the other cycle annealed, and still another quenched and drawn. The hardnesses varied from 143 to 200 BHN. The gears were lapped in these various conditions and in subsequent operations there was no difference in the tooth form of the three batches. The variation of form was noted as being the chief effect of the two previous questions.

Question: A 140-in. diameter ring, with a 4½-in. wall made of 4650 steel gave difficulty in the hobbing operation. The brinell hardness was 300 BHN. The gear had been normalized. What was the cause of the difficulty?

Answer: In steel of this type, draw operation should be incorporated after the normalizing to insure complete transformation. Further-

more, the all-over hardness may have been 300 BHN, but a survey of the micro constitutents may have showed variations of 200 to 400, with the average being 300. Therefore, in a case like this, the micro structure should be examined very closely.

Forgings

Question: In a forging operation, it was noted that distortion was greater in areas where flash was heavier due to wash of dies or heavier trim line. What can cause this condition?

Answer: A condition similar to excess flash was noted in shifting of forgings where greater distortion was noted at the point of maximum shift. It called for a variation in chucking procedures to eliminate this condition. It is possible that the variation distortion noted may be a function of localized work hardening due to heavier metal removal either in the machining or trimming operation. Along with this, the subsequent treatments may provide for a relief of stresses and strains of these operations. The cause of this condition may also be variations noted in machining of ferrite and pearlitic layers. The orientation of these layers in the work itself may have an effect on the subsequent distortion.

Question: If forgings were made in multiple off a single bar, and the last forgings were forged below what would normally be the forging temperature, would there be any subsequent effect noted on this particular forging?

Answer: There would be no difference in this forging and other forgings forged at the proper temperature.

Question: Are adjustments being made in machining operations where forgings are processed in lot forms?

Answer: Piloting of lots is a common practice, especially in spiral bevel gears and hypoid gears.

Surface Finish

Question: How smooth should a gear tooth be?

Answer: Shop blasting of tooth surface roughens the tooth considerably but, nevertheless, gives very satisfactory performance. The surface finish depends very largely on the requirements of the job. Where the speed is slow and pressure light, the gear faces can be relatively rough. On normal automotive and truck gears the finish as developed by any of the common cutting machines is satisfactory.

One user pointed out that on propellor drive gears, scuffing could not be prevented on finishes of 15 microinches. In an effort to eliminate this, a higher order of polish was adopted and the scuffing increased. Finally, a finish of 30 to 50 microinches proved satisfactory.

Question: How much tolerance should be given to the heat treat and how much to the machine shop?

Answer: It would depend upon which source was asked to delineate the tolerance. Excessive overages have been noted in both machining and heat-treating operations. One user reported one third of the tolerance for machining and two thirds for heat treating. This figure, of course, would vary with the type of gear and the application.

Shot Peening

Question: How much benefit can you expect from a shot peening in increasing the fatigue strength of gears?

Answer: This is dependent upon the residual stresses prior to shot peening. If they are largely compressive, the net benefit will be small. If they are tensile, you can expect a correspondingly greater increase in fatigue life.

Case and Core

Question: Is it necessary in case hardened applications to have a hard core as well as a hard case, or is a soft core and the hard case just as satisfactory?

Answer: This question has been debated. Work now in progress, which should be completed in a month or so, should go a long way in settling this problem. One user states that if the strength is sufficient to withstand the stresses at any level in the gear, that particular gear will stand up. If the stress exceeds the strength, it will fail. There are, of course, modifying conditions. For example, if the case is too thin, failure will occuur at the core. It is possible also that a split occurs in the middle of the case; however, this could be a function of residual stresses.

A greater amount of consideration must be given to internal stresses developed in a gear during treating. There is a variation in the Ms of the case and the core and the residual stress depends upon which portion is transformed first.

Question: What is a satisfactory core hardness for gears?

Answer: Gears with core hardness as low as 25 Rockwell "C" have run satisfactorily in service and were satisfactory on dynamometer tests. The hardness is not the only answer, since a duplex structure may be present. To have satisfactory performance, you must have a metallurgically sound core. However, generally, a hardness

of 25 to 35 Rockwell "C" is satisfactory for a core hardness.

If you have sufficient case depth, the hardness of the core will be of less importance. But it is not felt that there should be a great hardness differential because of possible residual stresses between the very hard case and very soft core.

Question: Where should the core hardness be measured, at the pitch line or at the root of the thread?

Answer: The cross sectional hardness survey should be made across the traverse of a tooth.

Alloy Selection

Question: What is the proper run-down of alloys for suitability of application?

Answer: In medium carbon steels used in the hardness range of 200 to 300 BHN, the type of steel does not make too much difference. The properties depend mostly on the microstructure. The section size or other service conditions will influence the choice of the alloy to be used.

On the carburizing grades for maximum service in heavy sections, the 3300 or 4800 steels are generally conceded to be of the very best of material. Hardenability-wise you would then drop to the 94B series, the 4600 series. 8600, 8100 and 5100 series, and finally down to the carbon grades. For proper selection, the section size and application must be taken into account.

Nitriding

Question: What causes cracking in grinding nitralloy material after nitriding?

Answer: One of the chief causes of cracking during nitriding is the prior structure of the material before nitriding. Nitrided materials must be quenched and drawn prior to nitriding. Another source reported that excessive cracking was noted along with the presence of a white surface layer on the nitride case.

Induction Hardening

Question: How much variation is there in the performance of induction hardened gears as compared to those which have been conventionally treated with longer soaking times before quenching?

Answer: This cannot be evaluated by a straight comparison with two gears treated in the two manners noted, since after heat treatment you are comparing two different tooth forms due to variation in hardening patterns between the two methods. Improvements have been made in machining and contours of induction hardened gears so that until now there is only a 10% variation between carburized and induction hardened gears on life tests on the dynamometer.

Question: In a gear-pinion arrangement, should the gear and the pinion be drawn or just one of the two members?

Answer: It varies with the manufacture; some manufacturers draw both, some do not. Some draw the gear slightly higher for lapping purposes. Another does not draw either the ring or the pinion when using 4800 series steel, but when leaner alloy came into use, he began to draw the pinion as a precautionary measure.

Flame Hardening

Question: In using a cast-iron gear in conjunction with a steel pinion, can the cast iron gear be hardened, providing you have adequate beam strength?

Answer: Pearlitic iron is being flame hardened on a very large scale for certain farm implement applications.

Question: Is spotty hardness present on a flame hardness surface?

Answer: There has not been definite check, but the gears have been standing up very well in service.

Question: When flame hardening large gears, are they spun during the hardening operation?

Answer: Gears in the neighborhood of 5 ft in diameter are not spun because of excessive warpage.

Question: How much time is required to heat a 15-pitch diameter by gear flame hardening?

Answer: After the conventional preheating operation to approximately 900 F, the hardening requires approximately 5 min.

Question: To correct heat-treat distortion, is it better to crown shave both or individual members?

Answer: It is sufficient to crown shave only one or the other member, but not both.

Question: When is it economical to crown shave gears?

Answer: If there is difficulty in the assembly or distortion in the heat-treating operation, it is always economical to crown shave. If you have no reason, it is not economical.

Jet-Engine Bearings Are Stumbling Blocks!

F. W. Wellons, SKF Industries, Inc.

Report on Round Table on High-Speed Rolling Contact Bearings, held at SAE Summer Meeting, Atlantic City, June 4, 1952, under auspices of SAE Aircraft Powerplant Activity Committee.

JET-ENGINE bearings are one big headache for bearing and engine manufacturers. Even in today's engines they pose many problems and are a limiting factor in design. Realization of tomorrow's higher thrust, supersonic engines, however, hinges entirely on better ones being developed.

Why are jet-engine bearings a stumbling block? What specific problems plague designers today? How are they being met? Let's survey the situation as it now exists.

Jet-engine main bearings are a designer's nightmare for three reasons—they must operate under high temperatures, loads, and rotating speeds. Put together, these requirements add up to an extremely difficult set of conditions to meet.

Sleeve bearings can't do it. Ball and roller bearings can—to a degree. That's because rolling contact bearings, among other things, are not so sensitive to oil flow interruption. This is very important. With jet engines, it's not uncommon for the bearings to operate without oil for short periods during engine starting or because of failure of the lubrication system. With sleeve bearings, this would be disastrous. With rolling contact bearings, this isn't always the case. Korean experience has shown, for example, that pilots and aircraft have been saved because engines continued to run for fairly long periods of time after complete loss of the oil supply.

Rolling Contact Bearings Are Good, But . . .

Rolling contact bearings, in themselves, then are good . . . as far as they go. But they don't go far enough—for today's engines or tomorrow's.

They do, for example, operate quite satisfactorily at temperatures up to 300 F. Sometimes, however, bearing temperatures exceed 300 F—and this spells trouble.

The bearing lubricant is perhaps the most important single limit to higher bearing operating temperatures. And, since petroleum fluids volatilize about as fast as they can be accepted in present engines, it's common practice to use low volatility synthetic oils.

But even synthetic oils completely volatilize under certain conditions . . . and this causes failure to occur at the crude plain-bearing surface where the cage is supported by either the race or the rolling elements.

This may happen, for example, when an engine is shut down. Residual heat in the turbine buckets, wheels, and other metal parts may "soak back" into the bearings, causing the lubricant to completely volatilize. Thus, during the subsequent start, these cage locating surfaces must operate under conditions of dry friction. The same sort of thing may be caused by interruption of the flow of lubricant to the bearings. But, in either case, bearing bronze rubs off very rapidly on the steel race locating surfaces—and failures may occur.

This problem can be, and is being, attacked in several ways. One rather successful approach has been to plate the bearing bronze with silver. The silver, being more compatible with steel, rubs off much slower. (However, this approach does offer one possible drawback. Silver is extremely sensitive to dirt that may be in the lubricant.) Modified H monel metal also helps, but it is very difficult to fabricate.

Another approach is to cut down the clearance at the edge of cage support surfaces. But this can only be done by finding a material which has nearly the same coefficient of expansion as the steel of the races.

Still a third—and possibly the best—approach is to use materials for cages which are inherently nonwelding even when operating at extreme boundary or dry conditions.

One such material is a phenolic now used in some

Jet-engine rolling contact bearings are good as far as they go, but they don't go far enough. Even in today's engines they pose many problems . . . realization of tomorrow's higher thrust engines hinges entirely on better ones being developed. That's the present-day picture as painted at the Summer Meeting Round Table on High-Speed Rolling Contact Bearings. And some of the suggested ways to cope with it were outlined by (left to right): Secretary F. W. Wellons, SKF; Daniel Gurney, Marlin-Rockwell Corp.; Stephen Drabek, General Electric; C. M. Michaels, Wright Air Development Center; E. F. Macks, NACA. Round Table Leader E. E. Bisson, NACA, was absent at the time this picture was taken.

high-speed ball bearings. Cages are machined from a phenolic compound which is made by winding fine cotton cloth on a mandrel, then impregnating it with bakelite. As a result, there are absorbent cotton fibers at all machined surfaces which hold enough oil so that the cages will operate satisfactorily even under marginal lubrication. Use of phenolic cages is limited to temperatures of 300 F, however, and this rules them out for future jet-engine bearings.

Other "non-welding" cage materials were recently investigated by the National Advisory Committee for Aeronautics. All the materials tested had to meet these ground rules: (1) a strength equal to that of commonly used materials, and (2) a thermal expansion coefficient as close as possible to that of the race material. Results of this investigation indicated that:

- The ability of materials to form surface films that prevent welding is a most important factor in both dry friction and boundary lubrication.
- Surface films are formed on cast iron, bronze, monel metal, nichrome, and beryllium copper.
- On the basis of wear and resistance to welding only, cast iron shows appreciable promise.

Too Much Heat on Rolling Elements

Cages that fail when lubricants evaporate aren't the only "temperature" weaknesses of today's jet-engine rolling contact bearings. Ball and roller bearings, themselves, made from such conventional materials as SAE 52100 steel, are not satisfactory in applications where outer race temperature exceeds 350 F. Thus, if bearing reliability is to be maintained in newer jet engines, new steels must be found.

In this quest for a better high-temperature steel, these points must be kept in mind and weighed carefully:

1. An analysis must be chosen which can be heat treated to obtain acceptable hardness — yet can maintain dimensional stability at the maximum operating temperature.
2. It must be possible to maintain a hardness of at least 58 R_c the maximum operating temperature. And the hot hardness must be essentially unaffected by extended service at this elevated temperature. (It is generally agreed that a falling off in hardness below this limit is accompanied by a proportionate decrease in bearing capacity.)
3. A suitable high-temperature steel should require a minimum of critical alloying elements, especially tungsten.
4. The analysis should be available from several competitive sources and be covered by a recognized industry specification.
5. Consideration should be given to heat treating and grinding characteristics. (It should be remembered that any bearing material suitable for high-temperature operation will be more difficult to manufacture than one made from SAE 52100 steel.)

Right now in England, 18-4-1 tool steel is used for high temperature applications. And while the M2 analysis with 6% tungsten has been used in the United States, recent thinking has favored M10 which requires no tungsten. Oddly enough, the mills which furnish M10 show up to 1% tungsten as an impurity because of the type of scrap they are obliged to use. Therefore, consideration has been given to using the M1 analysis which specifies 1½% tungsten.

Grinding studies, based on the time required for a given operation on an SAE 52100 steel ring, have shown that the corresponding grinding time cycle for a ring made of M1 steel is about 1.8 times as long. With M2, the time is about three times that of SAE 52100 and for M10 the grinding time ratio is up to four.

Specimens of M1, M2, and M10 steels, checked for hot hardness at various temperatures up to 700 F, showed about the same gradual falling off in hardness with increasing temperature. (Minimum hardness at 700 F was 58 R_c.) All specimens, when cooled to room temperature, recovered the full initial hardness of approximately 64 R_c.

Dimensional studies have also been made with M2 and M10 rings. Specimens were heated to various temperatures up to 900 F and held there for two hours, then cooled overnight to room temperature.

No diameter change was observed through 700 F and only negligible changes up to 900 F.

There's also a need for larger diameter bearings on new, large, single rotor engines. This comes from a desire to increase the critical speed of the shaft to well above the operating range. What's more, simplified designs of minimum weight can be achieved with large diameter, thin-wall shafting.

But engine designers must first maintain a safe operating linear speed for the bearings. And with the state of the art as it is, designers are forced to step down the diameter of the shaft which results in increased weight, complexity, and cost. This is a challenge to the ingenuity of designers!

Radial loads are not a problem with today's rolling contact bearings. Under normal conditions, the radial load is merely the weight of the rotor. And this is usually under 1000 lb per bearing, which is insignificant considering the size of the bearings.

It's true that gyroscopic loads due to maneuvers are very high. But since they are transient loads, well within the capacity of the bearings, the effect is one of shortened bearing life by quantities as yet unmeasured.

Thrust loads are a problem, however. Here the amount of radial load that a bearing can take within an acceptable life period is very low. And it's up to designers to juggle forces of tens of thousands of pounds (which vary with engine speed, air speed, and altitude) to keep thrust load on the bearings down to a few thousand pounds.

Balancing pistons are used for this purpose. But they mean added weight, cost, and complexity, and —perhaps most important of all—loss of compressed air. The latter, in turn, cuts down airplane range.

It's true that research knowledge in the field of high-speed rolling contact bearings is on a gradual increase. But demands of new aircraft engines are far in advance of present bearing research knowledge. Most of today's engines are being designed from extrapolated bearing knowledge. In many cases, bearings are a limiting feature in design, as even designers admit they cannot venture too far into the unknown.

The road ahead, then, involves a large amount of development work to produce reliable bearings that will be large in diameter, and operate at higher DN values, temperatures, and thrust loads.

Diesel Locomotives . . .

. . . can be mass-produced because different models use similar parts. Economies from rising production have kept price per horsepower unchanged since 1936.

Based on paper by **E. W. Kettering, T. B. Dilworth, and J. M. Norris**
Electro-Motive Division, General Motors Corp.

UNLIKE the steam locomotive which is made up of relatively few, mostly large and heavy parts, the diesel uses a large number of like parts regardless of model, and the flexibility of each model is still high. In the Electro-Motive diesel line, one traction motor serves everything from switchers to streamliners. There is one engine cylinder with all its associated parts—heads, valves, injectors, cylinder liner, piston, and so on. Engines are alike except for the number of cylinders which may be 6, 8, 12 or 16. There are two traction generators, one auxiliary generator, one fuel pump motor, two fuel pumps and so forth. By using these building blocks in various combinations, a variety of locomotives can be constructed.

Interchangeability makes mass production possible. And rising production has led to economies which have offset the increase in cost of materials and labor. The price per horsepower, about $104.00, has not changed since 1936.

Let's examine the 1500 hp type as an example. It has a transmission speed ratio of six to one, which means that full engine horsepower can be transmitted continuously from 10 to 60 mph, from 15 to 90 mph, or any other assigned value. The speed ratio is the property of the powerplant and transmission; the actual speeds in mph are a function of the gear ratio between traction motor and axle. For low speed and high tonnage a gear ratio of 65-12 may be used, whereas for fast passenger trains it might be 57-20. There is also flexibility of size. Diesels can be hooked together for single-cab, single-crew control, thus a 1500 hp unit can be hitched to give 3000, 4500 or 6000 hp.

Classification is often by pounds of weight per horsepower. Switchers fall into a 200-350 lb/hp range; high speed passenger locomotives run as low as 100 lb/hp on drivers. Freight trains in rugged country commonly weigh 2000 lb/hp; in level regions 4000 lb/hp, and sometimes 5000 lb/hp. A high-speed passenger train will use only 1 hp for each 500 lb weight.

Prorating these lb/hp figures to the automobile would give a Chevrolet about 1½ hp under freight train conditions and perhaps 7 hp for high-speed passenger service. In automobile terms, then, a train is lucky to run at all. But it does run—and very well—because the coefficient of rolling friction of steel wheels on steel rails is very low and because grades are gentle by highway standards. (Paper, "Diesel Locomotive Bug Hunters," was presented at SAE National Diesel Engine Meeting, St. Louis, Oct. 30, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers).

Why Power Train Parts

POWER train components on off-highway trucks equipped with torque converters last far longer than those on trucks equipped with mechanical drives. Maintenance information gathered from operators of trucks used for earthmoving, coal and ore hauling showed this to be true. Converter equipped trucks were found to give approximately:

47% more engine life

400% more transmission life

93% more differential life

What's the reason for this? A series of recent field tests provide the answer.

Off-highway trucks with mechanical or torque converter drives were operated over similar haul roads. Three classes of loads were adjudged to affect the life of their power train components—starting, shifting, and load variation. And in all three cases these loads were greater in magnitude on mechanical-equipped trucks than on converter-equipped ones.

For example, when the conventional trucks were started with heavy loads, the clutch engagement shock load was approximately 4.28 times that which occurred with the converter. Shifting shock loads with the clutch were about 4.25 times that of the converter. And load variation with the mechanical unit was about ±28% during a normal operating cycle, whereas the converter unit showed only ±14% stress variation. As for average shifting operations for both units, the load variation of the mechanical unit was approximately ±67% compared to ±25% for the converter.

In short, then, shock loads and load variation were much greater with the mechanical transmission . . . and this is what determines the life of transmission parts.

Assume, for example, that a unit operates at an average stress of 30,000 psi. If, however, stress actually varies from 20,000 to 40,000 psi, and the unit were operated 50% of the time at each level, life would be reduced approximately 56%. For that matter, if the stress varied from 10,000 to 50,000 psi, life expectancy—compared with that for the average operating stress of 30,000 psi—would be reduced 86%.

Now, using the observed operating stress values in Table 1, let's take a look at how stress variation and shock load stresses affect life expectancy of these two types of transmissions.

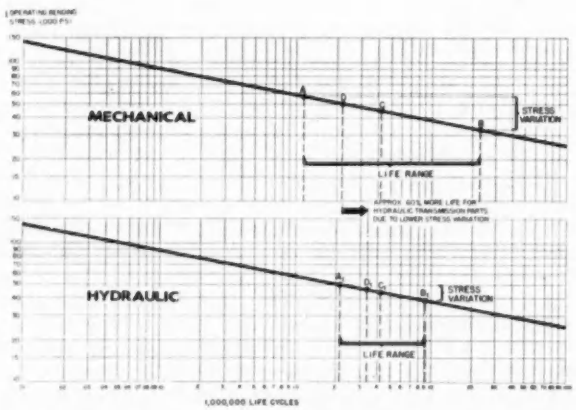


Fig. 1—Life comparison based on stress variation alone shows 60% more life for hydraulic transmission parts

Prefer Torque Converters

R. M. Schaefer and J. A. Winter, Allison Division, General Motors Corp.

Based on paper, "The Hydraulic Torque Converter—Its Effect on the Power Train" presented at SAE National Tractor Meeting, Milwaukee, Sept. 9, 1952. This paper will be published in full in the 1953 SAE Transactions.

Table 1—Operating Stresses for Hydraulic and Mechanical Transmissions

	Hydraulic psi	Mechanical psi
Basic Average Stress	31,200	25,000
Stress Variations	51,000	55,000
Shock Load Peaks		108,000
Observed Peak Loads	88,000	

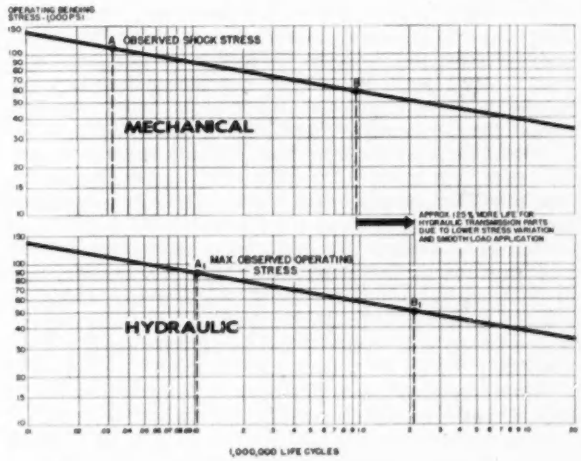

A OBSERVED SHOCK STRESS
MECHANICAL
APPROX. 125% MORE LIFE FOR HYDRAULIC TRANSMISSION PARTS DUE TO LOWER STRESS VARIATION AND SMOOTH LOAD APPLICATION
A1 MAX. OBSERVED OPERATING STRESS
HYDRAULIC
1,000,000 LIFE CYCLES

Fig. 2—Life comparison taking into consideration stress variation, shock and operating stresses, indicates 125% more life for hydraulic transmission parts

In the upper half of Fig. 1, the maximum stress for a mechanical unit is represented by A and the minimum stress by B . . . and this stress variation establishes life range. The total cycles for a constant mean or rated load is represented by C. But assuming that the unit operated 50% of the time at both maximum and minimum stress during the working cycle, life expectancy would then be represented by point D.

Next, let's do the same thing for a hydraulic transmission. The life range, A_1 to B_1, is shown in the lower half of Fig. 1. Here again, C_1 represents life with mean or average load, and the life indicated by D_1 would result from operating 50% of the time at the maximum and minimum stress levels.

Comparing the life cycles for points D and D_1, it can be readily seen that the life expectancy of the hydraulic transmission would be 60% greater than its mechanical counterpart. But this takes into consideration only stress variation differences between the two transmissions.

However, when shock and maximum operating stress loads are combined with stress variation, the hydraulic transmission shows 125% more life than the mechanical one. (See Fig. 2.)

In conclusion, then, since a torque converter eliminates shock loads when starting and stress variation caused by torsionals and resonance, the following things are true about hydraulic transmission parts.

Higher design stresses may be used.

For equal life, it is possible to use higher loading.

For equal loading, considerable more life will be obtained.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Complexity and Costs Force

The Systems

. . . to Air Weapons Development

Major-Gen. D. L. Putt, USAF, Air Research and Development Command

Excerpts from paper "The Systems Approach to Air Weapons Development" presented at SAE Annual Meeting, Detroit, Jan. 15, 1953.

(The four "air weapons systems" are—by Air Force definition—the strategic air system, air defense system, tactical air system, and air transport system.)

TODAY, because of high costs and complexity, we must analyze the many alternate systems for accomplishing each particular military mission in order to determine which system warrants development.

For instance, today we are faced with choosing between piloted aircraft and guided missiles for the performance of some of our military missions. Which weapon, considering the time period in which it will be available for operational use, will provide us the most lethal system at least expense?

Not only must we choose between two different types of weapons such as guided missiles or piloted aircraft, we must also choose between several guided missiles. We must choose between several forms of propulsion. Shall it be ramjet powered? Shall it be rocket powered? Shall it be powered with conventional turbojet engines? Such selections can only be made on the basis of an analysis of the operation of the complete weapon system. Selections cannot be made on the basis of a performance comparison of the mere weapons themselves.

Of course, systems can be different things depending upon whether you take a bird's-eye view or a worm's-eye view. For instance, the President may consider that he is concerned with a military system, an economic system, a political system, and a social system. But again the Secretary of Defense thinks of the military system as three systems: an air, a ground, and a sea system. The Chief of Staff of the Air Force considers that he has a strategic air system, an air defense system, a tactical air system, and an air transport system, plus some additional supporting systems such as reconnaissance, air intelligence, air weather, supply, and maintenance.

Going further down the scale, one could consider that within the strategic air system, the bomber itself, being an assembly of many components or sub-systems, is a system in itself. Then there are many other systems within the bomber, (be they called sub-systems or components), such as the propulsion system, the navigation system, the radio communication system, the photographic system, the bombing system, and the fire control system. For purposes of this discussion, these sub-systems are really considered as functional systems and not as weapon systems, in that they, of themselves, do not perform a complete military mission. It is only those four which I have mentioned, the strategic air, air defense, tactical air, and air transport that are, by Air Force definition, true air weapons systems.

A complete air weapons system includes not only the vehicle complete with its armament, radio, navigation, photographic, and other systems which takes off and proceeds to the enemy's territory, but also (as an integral part of that system) all the ground supporting equipment that goes with it, and

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Military to Take

Approach

. . . to Analysis of Aircraft Reliability

Ivan H. Driggs and John E. Forry, Navy Bureau of Aeronautics

Excerpts from paper "A Designer's View of Combat Aircraft Reliability" presented at SAE Annual Meeting, Detroit, Jan. 15, 1953

(The "system" here is a group of aircraft, such as a fighter group.)

PARALLEL duplication, while it increases combat reliability, also increases maintenance. Availability can be kept equal to that of the unduplicated airplane only by increasing the component reliability. The new component reliability if provided in unduplicated systems may increase the reliability of the airplane almost to that of the airplane with duplicated systems.

In view of the substantial weight penalty of parallel duplication, the conclusion seems inescapable that emphasis ought to be on other methods of obtaining greater reliability than by duplication. The attack should be in the direction of better quality, more conservative design, and elimination of parts.

The postwar trend toward designing increased combat effectiveness into military aircraft has resulted in large, costly airplanes which are logistically expensive to operate. These new airplanes are infinitely more complex than those of World War II. Therefore they are inherently of a lower order of reliability, so that a substantial amount of the designed combat effectiveness may be lost by failures in flight.

Because of airplane cost it is extremely important that this combat effectiveness be maintained at the highest value possible.

Parallel duplication of components has been widely adopted in modern aircraft to insure this effectiveness. In this method, it seems clear that the airplane weight and size will always suffer. Therefore it is necessary to evaluate the increased reliability obtained against weight penalties and maintenance requirements. Consideration of maintenance requirements introduces the concept of availability. The word is used here in the sense of:

$$\frac{\text{Sorties actually flown}}{\text{Sorties possible if all aircraft were in commission}}$$

Availability is related to "mission reliability" through maintenance requirements. Fig. 1 shows one way in which this relationship might be conceived. This plot is not intended to be quantitatively correct. Nor is it guaranteed that the lines on it should be straight or curved. It shows that for some relatively low maintenance effort in man-hours per airplane, 100% availability can only be maintained at very high values of reliability, simply because the lower the reliability, the more repairs must be accomplished. By increasing the effort, 100% availability can be maintained at lower reliability. But there is some limit to the number of men who can usefully work on any one aircraft.

Therefore, the time available for work sets a limitation on the number of man hours which can be applied. This limit is not critical where time between sorties is long, say 10–12 hr, as shown on Fig. 1, well over to the left. But as time between sorties decreases, the limit moves to the right

across the chart and there is certainly some time between sorties at which it becomes a very real limit, below which the overall aircraft reliability cannot fall and availability be maintained.

To examine the effect of this limit and the effect of duplication of components on the maintenance effort required, consider an extremely simplified example. Suppose that the military situation demands round-the-clock operations by a group of fighters. For simplicity, divide the group into two squadrons, which fly alternately. This is not an uncommon situation. Thus the time available for maintenance is approximately equal to the duration of each sortie. As high speeds of aircraft increase, their cruising speeds increase, and assuming constant combat radius, the duration of each sortie decreases with increasing cruise speed. Turning back to Fig. 1, the time available for maintenance determines a minimum reliability for each cruise speed in order to maintain a certain level of availability. Fig. 2 shows the general form such limits may take as a function of cruise speed and availability levels.

Maintenance force requirements also are affected by the time available for performing maintenance. Maintenance effort was discussed earlier in terms of man-hours; if the number of hours is reduced, the number of men and tools must increase. Fig. 3 is a plot of this relation in terms of cruise speed and reliability for one selected value of availability, 85%. Maintenance force requirements are plotted in terms of those required for a 200-knot cruise airplane with 95% overall reliability. For any level of mission reliability, it is seen that maintenance force requirements increase rapidly with cruise speeds. It was shown in Fig. 2 that there is an absolute level of reliability below which a given availability cannot be maintained. This limiting reliability appears as a cut-off on Fig. 3, and shows that as high speed and cruise speed increase, the overall reliability of the airplane must be increased. This is completely at variance with the trend toward greater complexity which has accompanied post-war speed increases. At this point, the effects of duplication of components can be shown to become significant.

The preceding discussion has been concerned with mission reliability, which is the probability that all components of an airplane will survive for a complete round trip. But the military aim of duplication is to increase combat reliability—the probability that the combat effectiveness will be unimpaired to and through combat—although mission reliability is also affected.

Consider first the effect on mission reliability. Assume, for the purpose of illustrating trends, that *all* components of the aircraft which require maintenance are to be duplicated with an additional unit of equal reliability. Since twice the number of units are carried, twice the number of repairs, on the average, will be required after each mission. Thus maintenance requirements in man-hours are approximately doubled. But a probability analysis reveals that, while the number of failed components is twice, the number of aircraft affected is almost twice, so that the limitation due to number of men who can work expands almost as rapidly as do the number of repairs to be made.

From this it can be concluded that the major effect of parallel duplication is on the maintenance effort required to retain the unduplicated level of availability. Maintenance force requirements are increased as the effort is increased. Fig. 4 shows the relative force requirements. Now the same quality of components used in a duplicated and unduplicated system result in two different levels of mission reliability. The two levels are tabulated on Fig. 4, for simplicity their approximate value being shown rather than their precise value. By comparing with Fig. 3, it is seen that mission reliability must be increased substantially over that of an unduplicated system in order to retain the same availability with an airplane of equal performance using the same maintenance force.

In many situations the maintenance force is subject to extremely inflexible limits, leading to the conclusion that component reliability must be increased if availability is to be retained in a dupli-

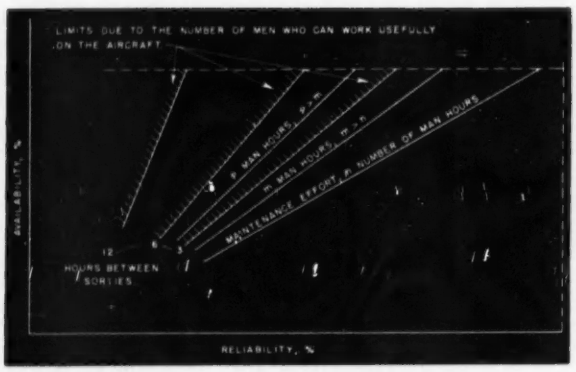

LIMITS DUE TO THE NUMBER OF MEN WHO CAN WORK USEFULLY ON THE AIRCRAFT
AVAILABILITY, %
MAINTENANCE EFFORT, P NUMBER OF MAN HOURS
HOURS BETWEEN SORTIES
RELIABILITY, %

Fig. 1—Effect of reliability on availability and maintenance requirements of a given sample or group of aircraft

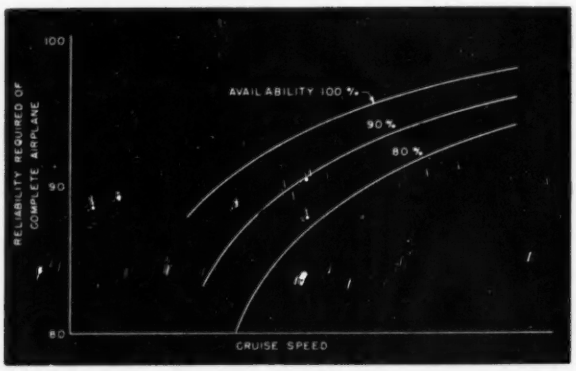


Fig. 2—Effect of cruise speed on reliability required. Curves based on limit due to number of men who can work

cated system. Increased component reliability must come from higher quality, conservative design or the number of components must be halved by a simplification program to counter the effects of parallel duplication on maintenance problems.

Parallel duplication of components does increase combat reliability. Simple probability analysis shows that a combat reliability of 95% with single components increases to over 99% by duplication of all components. Aircraft with lower reliabilities would experience even larger percentage increases. But these gains must be weighed against maintenance requirements, and very likely reduced availability to determine whether combat effectiveness of a given group of aircraft is increased or decreased by duplication.

Another effect of duplication is to increase the gross weight of the aircraft. Fig. 5 shows the gross weight of an airplane designed to some given high speed, combat radius, and military load if certain component systems are completely duplicated. These results are obtained by estimating the incremental weights due to duplicating complete systems, and, using the methods of the Research Division, Bureau of Aeronautics, converting these component weight changes into gross weight changes. The gross weight to perform the mission increases by 50% when only three systems are duplicated. This indicates that one out of three airplanes without duplication could fail at the combat point and be ineffective before duplication would be desirable on the basis of gross weight.

It must be recognized that this analysis has ignored completely the safety-of-flight aspects of reliability. This is a very important phase of the problem and when considered biases the results in favor of duplication. Perhaps it should more properly be said that safety of flight biases the results in favor of greater reliability, but it is a foregone conclusion that greater reliability is desired; therefore, safety of flight only reinforces the need shown by other aspects of operating the combat airplane.

The example given shows that duplication can

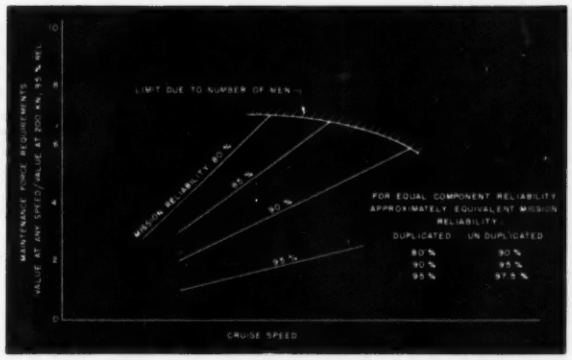


Fig. 4—Effect of cruise speed on maintenance force requirements with parallel duplication. Availability is 85%

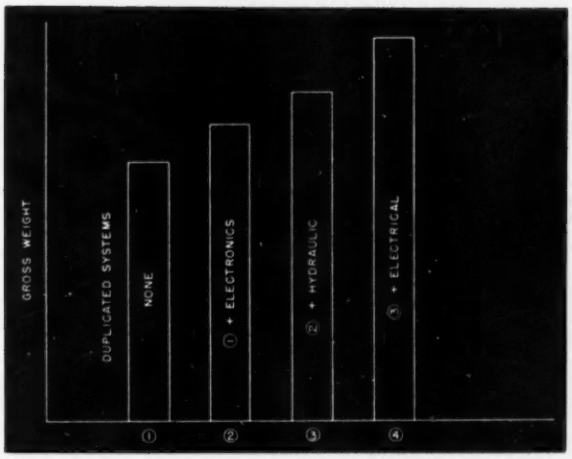


Fig. 5—Effect of duplication of selected systems on aircraft gross weight

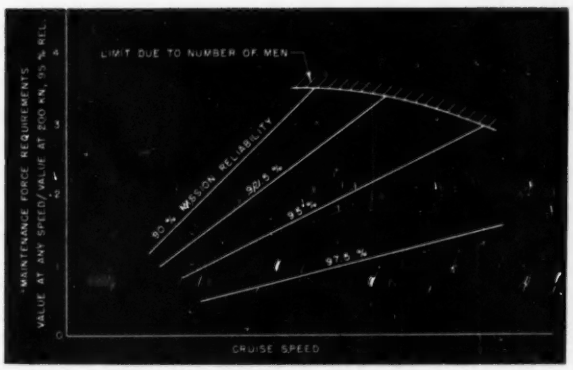


Fig. 3—Effect of cruise speed on maintenance force requirements. Availability is 85%

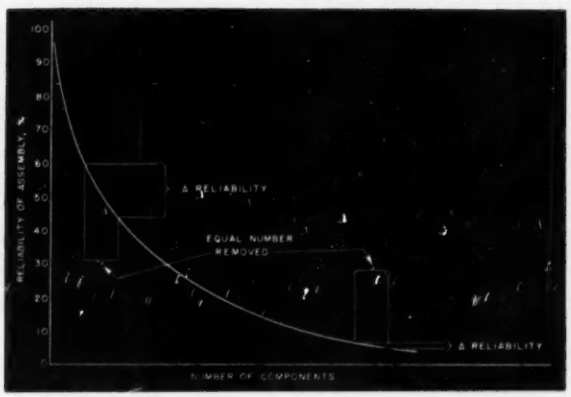


Fig. 6—Reliability of an assembly versus number of components

increase the combat reliability from 95% to 99%. But the overall mission reliability is required by maintenance considerations to be maintained constant even though number of components is doubled. This can be done only by making components more reliable. The new level of required component reliability results in an increase of combat reliability from 95% to 97.5% for an unduplicated system, almost as great as that obtained by duplication.

To repeat, the example shown is not intended to be quantitatively correct, but merely to show trends.

There are at least three means other than parallel duplication available to the designer by which reliability can be made a design variable. One way is to increase the reliability of aircraft components by selective inspection, adoption of more expensive production techniques, and other similar devices. If the original quality of components is relatively low, significant gains in reliability can be achieved by this approach, but at increased dollar cost and reduced volume of production. Size and weight of the airplane is not appreciably affected.

Another means of increasing reliability is to reduce the number of components, since reliability drops off exponentially with the increase of the product of the number of components and the average probability of failure of each component. This approach is the simplicity part of the "simple and reliable" axiom. It is effective in tending to increase reliability, but the numerical value of the increase for each component removed is dependent on the total number of components.

Fig. 6 shows a typical variation of reliability with number of components. For an initially low number of components, removal of a given number will increase reliability almost 5 times as much as occurs with an initially higher number, in the example shown.

Simplification would normally be expected to reduce aircraft weight, but may have the opposite effect if the simplified component should be less efficient weight-wise than the more complex. An example of this is the airplane engine, where a complex control is used to safely extract the maximum performance of which the engine is capable, and simplification may reduce thrust output and increase specific fuel consumption because fineness of control, permitting operation near dangerous regions, can be lost by simplification.

A third method of increasing reliability is conservative design. This is the method used to obtain high reliability in stationary powerplants, home radio sets, and such items—and leads to increased weight. It seems unsuited to combat aircraft design, but cannot be lightly discarded since other methods also lead to weight increases on many occasions.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Air Weapons Development — continued from page 60

the bases from which it operates. Further included are the logistical supply, maintenance, and transportation systems that keep the bomber, fighter, or transport in the air, the back-up of training bases, training aircraft, training schools, which are used to train its pilots, and the mechanics and other specialized personnel. All of these elements are just as much a part of the air weapons system as the aircraft itself.

Another way of thinking about systems in general (including both the air weapons systems and the functional systems) is to think of them as being different orders of systems. To the development engineer in a powerplant laboratory, the engine itself is a system, composed of many subsystems; the ignition system, the fuel system, the oil system, the air intake and exhaust system, and still others. To this engineer, the engine is a high order of system. But we are primarily concerned with the more embracive air weapons systems.

Let me next explain what I mean by the systems approach. The systems approach implies more than mere systems analysis. First there must be planning and programming for our air weapons development, which is done on a systems basis and which involves systems analysis before arriving at decisions. The plans and programs must then be implemented on a systems basis, requiring that we have systems management. Also, to insure that all of the parts of the system come out even at the end of the system assembly line, it is necessary that we have systems scheduling. All the components of the system, from spark plugs, to trained personnel, to air bases, must be scheduled to be ready, available, and operational at the proper time.

During the research and development period for the components in the sub-systems which make up this air weapon system, we must employ applied systems engineering. All components must be engineered to fit together into an integrated system, so that each will perform its individual function and operate in concert with all of the other components comprising the system.

Of course systems analysis, systems engineering, the systems concept, and the systems approach are not new discoveries made by the Air Force. Systems engineering, systems analysis, and the various techniques involved have been applied for many years in

other fields. Perhaps the best example of this is the development of the modern telephone system. The Bell Laboratories, engaged in the research and development of communications systems, have employed the systems approach to the solution of their problems because the complexity of the telephone communication system has made it imperative. Likewise, the development, installation, and operation of our large electrical power distribution systems have required systems engineering. But it is only recently that our air weapons systems have become so technically and scientifically complex that it has been necessary for us, in the development of our future air weapons, to think in terms of the systems approach.

Let me now illustrate how the Air Force is organized and how it operates to apply the systems approach to the development of our air weapons.

Let us take, for example, the Air Force's strategic air weapons system. Within the organization of Headquarters, U. S. Air Force in the Pentagon, there is the office of the Deputy Chief of Staff for Development, and within that office is the office of the Assistant for Development Planning. These people are a small but highly competent group of civilian and military persons who are unhampered by the day-to-day operations of the Air Force. Their job is to contemplate, think, look into the future, and plan for the weapons the Air Force should be developing. The end product of the efforts of this small group is what we term the Development Planning Objective for strategic air operations. This Development Planning group, being small, of necessity, does not do all of the work itself. Its primary mission is to pull together the work of all of the many groups, both within and without the military who can contribute information, data, analysis, or assistance in determining what our plan for the development of a future strategic air weapons system might be.

One of the major factors considered in the formulation of a Development Planning Objective is our national policy or objectives. This policy materially affects the development of our weapons. If our national policy were one of aggression rather than maintaining the peace, the nature of the weapons systems to be developed might be materially affected.

The office of the Assistant for Development Planning must also consider military strategy and tactics, as developed by our operational people. War plans, intelligence information on the capabilities and the potential of our probable enemies, the weapons which they have and which our intelligence people tell us they are developing, where they stand technically—all must be considered.

We must consider our own current operations, the equipment within the present force, always keeping in mind that a complete force cannot be replaced overnight and that we are faced with time phasing operations. We must phase in new equipment and phase out old in an orderly and economical manner. Knowing where we stand today we must consider our current deficiencies, either in our present military operations or in future military operations as we see they might develop. And, last but certainly not least, we must consider the state of the art. Whereas, all of the previous factors may indicate what we would like to have, the state of the art is a measure of what it is we can have irrespective of what we would like to have.

In considering these factors, you can readily see that information from the State Department, the National Security Council, the National Security Resources Board, the Joint Chiefs of Staff, studies of the Central Intelligence Agency and the intelligence agencies of our own three services, Army, Navy, and Air Force are all involved. These studies must all be considered. To obtain the state of the art, we must have information and studies from industry, from scientific circles, from people who actually establish and determine the state of the art and its rate of progress.

Research Put on Systems Basis

Incidentally, the impact of systems thinking or the systems approach to air weapons development has been so great that several organizations and *ad hoc* study groups have been or are now operating on a weapon systems basis. The RAND Corp. devotes its time almost exclusively to systems analysis to determine preferred weapons and techniques for the carrying out of air operations. In the past year, civilian scientific study groups have been organized; one for the study of air defense operations, another to study the problems of tactical air operations. A group at the Harvard School of Business Administration is currently studying air transport systems. As a result of the recommendations of the Air Defense study group, an Air Force laboratory manned and operated by M.I.T. under contract to the Air Force has been established for research and development of air defense systems alone. Here we have a laboratory organized on an air weapons system basis, rather than on the basis of a technical field, such as propulsion, electronics, or armament. Such organization points a significant trend and we will undoubtedly see other laboratories organized in the future on a similar basis.

To return to the Development Planning Objective, this becomes a document which expresses in rather broad terms the development objectives for a strategic air weapon system. It would include such general considerations as the required range of an intercontinental bombing aircraft (as determined by a study of global geography and the present alignment of powers). It would state the probable operating altitudes that would be required to insure arrival at the target and delivery of the munition on target. It would include a consideration of probable enemy defenses that would be encountered and how best these might be avoided. It would give the time scale as to when certain objectives should be met and certain weapons available for use in order to insure technological superiority over the enemy.

After approval by the Air Council and Chief of Staff of such a Development Planning Objective—which may cover a 10-year to a 20-year period, this document then becomes a guide for the formulation of what we call General Operational Requirements for which the Director of Requirements in Head-

quarters U. S. Air Force is responsible, and which breaks the strategic air system into its various components or sub-systems, such as the bomber itself, the navigational system, the bombing system, and others, and sets forth in more specific terms the operational environment in which the equipment must operate and the requirements which must be met by the next family of equipments to be developed to fit into a system.

The General Operational Requirements, having been established, are then transmitted to the Director of Research and Development, still in Headquarters, who breaks the various jobs down into development directives and forwards these to the Air Research and Development Command in Baltimore for implementation. Here, the work is planned as to how it will be accomplished; how the work will be divided between the nine research, development, and test centers of the Air Research and Development Command; and directives are sent to each of these Centers for the part of the work that they are to accomplish.

The planned objective, having been broken down into its various components and pieces, now becomes a management problem to insure that a complete weapons system will be developed and ready for combat at the proper time. To effect this management, on a systems basis, there are within the office of the Deputy Chief of Staff, Development, offices individually responsible for, and organized on a systems basis. For instance, although the Office of Director of Research and Development in the Pentagon is organized into technical divisions —such as aircraft and guided missiles, armament, electronics, and equipment—over them and reporting directly to the Director of Research and Development are Assistants for strategic air systems, tactical air systems, air defense systems, air transport systems, and supporting systems.

The same is true within the organization of the Headquarters of the Air Research and Development Command. There in the Deputy for Development, (also superimposed upon the various technical divisions) are offices concerned solely with the major air weapon systems with which the Air Force is concerned. Where appropriate in some of our Centers, there are offices which are organized on a weapons systems basis in order to insure this complete systems integration management and engineering.

Within our nine Air Research and Development Centers, it is likewise necessary that systems analysis be used in addition to good systems engineering to insure maximum returns on our research and development efforts. Let me illustrate this by using a component of a system, the day-fighter—which, in itself, is composed of several sub-systems—but can be used to illustrate the type of systems analysis that is being used in evaluating and developing our weapons.

Naturally we are endeavoring to maximize the kill potential of our fighter aircraft. The weapons systems approach which welds the airframe and its armament and equipment into an integrated military machine dictates that the proper balance be preserved among the components of the whole. Each component must justify its place on the team, and any part of the team that is a weak link in the chain or has a difficult task to perform receives special emphasis, special care, selection, and exhaustive proof tests before adoption.

Even in our process of contracting, the systems approach has changed our procedures. In the past it was customary to break any particular system such as the airplane down into its many components and contract with many different contractors for the development of those components, leaving it then to the research and development center to insure good systems planning and systems engineering and coordinating the effort of many contractors to insure a completely integrated system. We are

F-86's Success Against

THE performance of the F-86 versus the MIG-15 in Korea today proves that the Air Force has placed a well-balanced weapons system against the enemy, General Putt says in the complete paper from which the accompanying article is excerpted.

Although USAF planes are outnumbered, forced to fight in an unfavorable tactical situation, and giving the enemy the advantage of a privileged sanctuary, the ratio of MIG-15 kills per F-86 loss has continued to climb and late in 1952 stood at 8 to 1. The two airplanes are about equal performance-wise. The superlative training given U. S. pilots is about balanced by the tactical advantage and superior numbers of the enemy.

General Putt explains this success partly by reasoning that our pilots do four things: first, the pilot forces the enemy into combat; second, the pilot has to close to effective range; third, he has to secure hits; fourth, hits have to be lethal.

Since these are serial events, the probability of a successful mission is the product of the individual probabilities of successfully accomplishing each step. This

now, however, attempting to give more and more of the complete system to one contractor and make him responsible for the complete systems integration and subcontracting for many of the components formerly contracted for by the Air Force.

To sum up, we see that the systems approach to air weapons development involves systems planning and programming, systems management in implementing those plans, systems engineering to insure that the bits and pieces fit and operate together, and proper systems scheduling to insure that the bits and pieces are all completed at the proper time to provide the completed weapon. Having accomplished all this, our hope then is for a completed weapons system on time, in proper quantity, of superior quality, integrated into an organization trained for its employment, and ready to do battle if ever necessary.

The Air Force today is convinced that the aircraft industry including its component and accessory subcontractors must join us in the greater application of the systems approach to air weapons development to achieve more airpower per tax dollar.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

MIG-15 Proves Weapons System Well Balanced, Putt Says

might be expressed by a formula as follows:

$$P_{k/s} = P_E \times P_c \times P_H \times P_k$$

$P_{k/s}$ = Probability of a kill per sighting
P_E = Probability of engaging the enemy
P_c = Probability of closing to effective range
P_H = Probability of hitting
P_k = Probability of kills from hits

If 50% of the sightings turn into engagements, and 20% of the engagements result in the F-86 closing to effective range, and there is a 50% chance of getting hits when in range—and a 50% chance that hits are lethal—the product is 2½%.

It is best, of course, to maximize the product of these factors and not any one component. For instance, one might consider installation of a larger cannon on the F-86, since we are getting about as many (as you read in the newspapers) damaged MIG's as kills. But, even if every round were a 75 mm shell and every hit were a kill, the 2½% could only increase to 5% and then only if all of the other factors were not affected, General Putt points out. Obviously, the second term, P_c, the probability of closing, which is dependent largely upon the performance of the aircraft, would change disastrously as the slight margin of aerodynamic performance disappeared under the weight and drag of the heavier cannon.

The third term, the probability of hitting, may be the margin of overall performance that accounts for the success of the F-86 over the MIG-15. If so, these day fighter engagements are proof of the soundness of the weapon systems concept. They are the measure of the payoff for balanced design. If this is indeed the margin of overall superiority—and General Putt believes that it is—it has been obtained through the development of what some would call a too complex fire control system. This system incorporates a small radar that automatically measures range to the target and, through gyroscopes, continually furnishes information of the relative speeds and angles of the attacking and target aircraft to a computer which automatically places the correct lead angles into the sight for the pilot, Putt explains.

In present-day combat of jet fighters, no human being has the sensory capability to measure the enemy's speed, range, and the angles involved. One can see from an examination of the formula that this term, the probability of hitting, is particularly critical in that, unless hits are obtained, no matter what are the values of the other factors, the net result of the mission is zero. It must be a source of great embarrassment to the Red leaders that their MIG's are consuming tons of fuel and creating much air turbulence with little or no results, General Putt concludes.

Stop Those Skids!

A. C. Gunsaulus, Goodyear Aircraft Corp.

Based on paper "Rolling Wheels Gather No Skids" presented at the SAE National Transportation Meeting, Pittsburgh, Oct. 23, 1952. This paper will be published in full in the 1953 SAE Transactions.

TRUCKS and buses will not skid—tractor-trailers will not jackknife—even on the most slippery roads—if each braked wheel is equipped with a new electrical device designed to prevent premature stopping of the wheels.

Skidding cannot occur as long as the wheels are kept rolling. Skidding occurs when overbraking locks the wheels so that the tires slide.

The new control device is able to prevent skidding by, first, sensing the impending skid, and then preventing it by keeping the wheel rolling.

This principle was first used in the design of an antiskid unit for airplanes. The device has now been adapted for truck use, where it has been found most effective in preventing skids.

Why the Device Works

When overbraking takes place on a vehicle that does not have these control devices, the following sequence of events takes place, leading to the skid:

1. Brake pressure on, brake torque develops.
2. Brake torque exceeds wheel torque.
3. Wheel begins premature slowdown.
4. Wheel stops, tire slides, and skid begins.

The new device utilizes event No. 3—the premature slowdown—as a warning of event No. 4.

With controlled wheels, the braking sequence becomes:

1. Brake pressure on, brake torque develops.
2. Brake torque exceeds wheel torque.
3. Wheel begins premature slowdown.
4. Sensing element signals slowdown.
5. Brake pressure relieved by signal.
6. Brake torque decays, wheel rpm recovering.
7. Wheel rpm recovered, pressure reapplied.

These events are illustrated in Figs. 1 and 2, where wheel speed and brake pressure are plotted against time for the braking sequence both with and without control. In both cases the plotting of an actual stop on a slippery road surface has been keyed to the event schedules just given.

Thus, in Fig. 1:

(1) shows the brake pressure buildup and normal wheel slowdown that occurred when the brakes were first applied.

(2) shows the point where brake torque exceeded wheel torque, and the wheel speed began its precipitate decay. (This event occurred 0.5 sec after pressure was first applied.)

Brake pressure continued to build up until, at (3), the wheel had slowed down appreciably. By (4)—only 0.6 sec after the wheel speed began to drop off rapidly—the wheel had stopped rotating, sliding had begun, and the tire began to skid.

We went from initial brake application to skid in 1.1 sec, but, since our control system did not begin to act until 0.5 sec had passed, we had only 0.6 sec in which to correct the overbraking.

The driver received no warning of the impending wheel stoppage. Moreover, even if he had been warned, 0.6 sec wouldn't have been long enough for any constructive action on his part. Furthermore, in laboratory dynamometer tests, as little as 0.3 sec between the start of slowdown and the actual wheel stoppage have been recorded.

Fig. 2 shows what happened in one typical case when the control device was used.

(1) shows the brake pressure as well as the brake torque buildup.

(2) shows the point where the brake torque exceeded the wheel torque.

(3) is the point where the wheel began its faster-than-normal slowdown.

At (4) the abnormal slowdown had been signaled.

By (5) the brake pressure had been relieved and brake torque had begun its decline.

(6) shows when wheel rpm recovery was well under way.

By (7) the cycle was complete, the wheel had recovered and brake pressure was again being applied.

Since the wheel never stopped rotating, it was never out of control.

In this exmple, about 1.2 sec elapsed for the complete cycle, but again complete cycles lasting only 0.5 sec have been recorded in the laboratory. These split-second operations are naturally much faster than any known human reaction time.

Fig. 3 shows the basic circuit of the control device.

A small d-c generator having a voltage output directly proportional to its armature speed (24.3v variation per 1000 armature rpm) was chosen for the quick detection of the sudden changes in wheel rpm. A 4 to 1 stepup gearbox provides sufficient armature speed at low wheel speeds.

Since the power output of the sensing generator is too small to power the solenoid brake pressure valve, two electrical relays, a condenser, and a battery are interposed between the generator and the brake valve. In this way the weak sensing signal is multiplied and reinforced.

The sensing circuit consists of a small d-c generator, the condenser, and the coil of the current-sensitive relay, connected as shown in Fig. 3.

To activate the control, current must flow through the coils of the current-sensitive relay. The generator armature is directly connected to the wheel it controls and always rotates in unison with it.

The generator and condenser occupy opposing positions in the circuit diagram. The condenser will not permit a pure. steady direct current to flow through it—a current such as generated during a normal wheel slowdown. It will, however, permit the voltage to charge its plates. Thus, a sudden change in generator voltage, such as occurs with a rapid change in speed—either up or down—will upset the condenser plate balance or voltage equilibrium. Condensers are inherently balancing mechanisms, and in its effort to maintain voltage equilibrium on its plates, the condenser will discharge and current will flow in the circuit. This current will pass through the coils of the relay, causing its switch to close and pass a signal to the relaying circuit.

The signal received energizes the coil of the second relay and closes its switch. It thereby starts a current through the solenoid coils of the pressure valve. The second or relaying part of the system is necessary because the switch points of the current-sensitive relay used cannot carry as heavy a current as is needed to energize the solenoid. Another relay was introduced big enough to carry this solenoid current.

In the third or valving circuit, the closing of the switch in the second relay permits power from the battery to flow through the coil of the solenoid valve, closing off the flow of pressure to the brake. Whatever pressure existed in the brake chamber is released to the atmosphere.

The sensing circuit initially signaled a wheel slowdown. This signal eventually caused the brake valve to open and relieve the excessive brake pressure. Succeeding signals by the sensing circuit, while the wheel rpm was recovering. kept the circuits energized and the brake valve open until the wheel had again reached its proper speed. When the wheel speed stabilizes and the sensing signal ceases, the brake valve again closes, admitting pressure to the brake chamber, and the cycle of control has been completed.

Fig. 4 shows how each sensing unit was attached by means of an adaptor to each rear wheel of the truck. The side arm extending out from the truck body provided a suspension means for the wire lead coming from the generator as well as a spring-loaded link that restrained the rotation of the generator body when the wheel was driving its armature.

Leads from the sensing circuit were carried to the cab where the relays and battery were located. From here the leads ran back to the solenoid valves. A pair of switches in the cab permitted the operator to select "control" or "no control" at any time. As a safety precaution, a pressure-operated switch, located on the air supply tank of the brake system and set to operate whenever the pressure dropped below 30 psi, would automatically throw out the control circuits when the air supply got too low.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

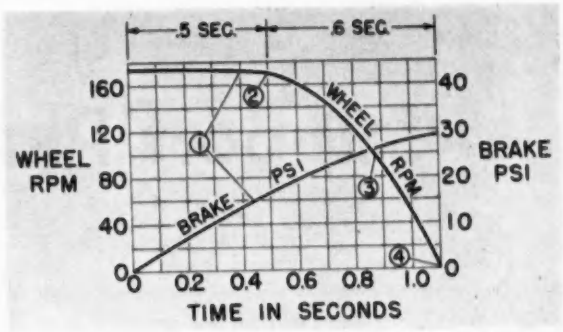


Fig. 1—Braking sequence without individual control

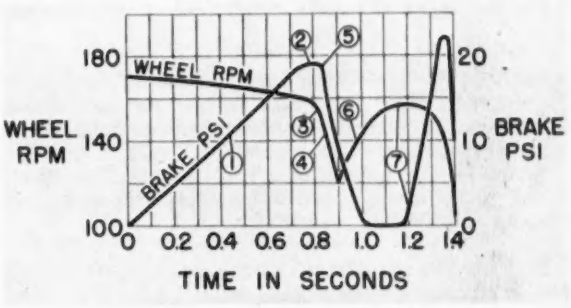


Fig. 2—Braking sequence with individual control

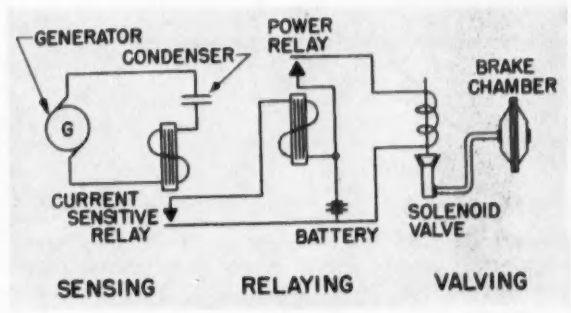


Fig. 3—Basic control circuit

Fig. 4—View showing how unit was installed on each truck rear wheel

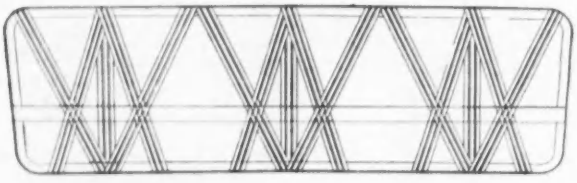
Support Plus Some Softness

Prescription for Better Passenger Car Seats

PRESENT at the round table discussion on automotive seating described in the accompanying article was Dr. Louis Fox to describe a seating device he has developed. Dr. Fox claims that his device will not let you slouch and it automatically eliminates the unrestful curve of a sagging seat and gives instead comfort and relaxation.

Fig. 1 shows the device. It consists of wide rubber bands stretched over a steel frame, which is to be sandwiched between the usual springs and an inch of rubber padding on top. The interlaced bands

Fig. 1



provide support to the ends of the pelvic bones, where the support should be for good posture. Because the position of these bony protuberances, called the ischial tuberosities, varies only slightly from person to person regardless of weight, one pattern of interlacings accommodates all drivers.

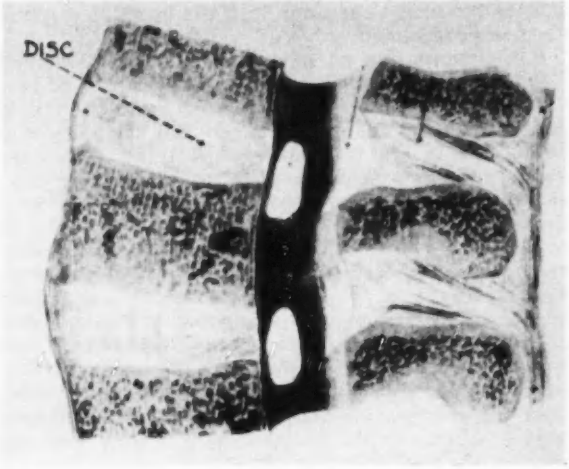
A panel member who had driven a car equipped with a padded, single-seat version of the frame added to the regulation seat reported that he found he could sit up straight on the frame and drive for hours without feeling tired. However, on short trips, if he tended to slouch and did not sit on the pad in the proper position, then the seat gave him the uncomfortable feeling of sitting in a hole.

Dr. Fox explained that the seat was purposely designed that way to make the driver sit up straight. He contended that slouching can lead to painful trouble to the cartilaginous cushions between the vertebrae (Fig. 2). Slouching compresses the forward part of these intervertebral discs and stretches the rear. This situation is bad enough in a living-room chair; in a car going over bumps the situation is worse, he said.

More and more middle-aged people are suffering from injured and ruptured discs. The condition can be corrected only by surgery. Dr. Fox reasons that it would be better to build the support into all passenger cars than to risk greater prevalence of injured discs among people who spend long hours in cars.

Besides engaging in private practice, Dr. Fox serves as medical director of the New York Curb Exchange and RCA Communications and New York medical representative of Gulf Oil. He has a patent on his seating device.

Fig. 2



Should Be Goal for Car Seats

J. C. Gordon, Vice-President, Gordon-Chapman Co.

Secretary's report of round table discussion on Automotive Seating held at SAE Summer Meeting, Atlantic City, June 2, 1952, under the auspices of the SAE Body Activity.

Questions and Answers Concerning Seats

What are the static requirements of a seat cushion for passenger comfort?

Primarily, the seated human structure requires vertical support on the ischio-tuberosities, the two bony protuberances we sit on. The soft tissues of the thigh are not adapted to take any sustained pressure. The pressure a person can stand comfortably increases from knee to rump, and tapers off from the small of the back to almost nothing at the neck.

A short person on a deep cushion gets pressure under the knee; possibly he doesn't even have the weight of his feet on the floor. For this reason, it's better to design the cushion for the short person, and let the tall person accomodate himself to it.

To insure static comfort, the seat designer should aim to

1. Support the passenger over a large area so that unit pressure on the flesh is small.
2. Avoid variations in pressure from point to point over the supported area except those variations dictated by the human anatomy.
3. Provide a cushion that when loaded will have a contour and pressure distribution that will be comfortable for most passengers.

What are the dynamic requirements of a seat cushion for passenger comfort?

There are two fundamentals to consider, vibration transmission and human tolerance to vibrations.

The natural frequency of the sprung masses is well below 100 cpm. For handling that type of disturbance, you want the natural frequency of the passenger on the cushion to be at least 40% greater than the highest frequency of this car suspension. For a natural suspension frequency of 70 cpm, we want the passenger on the cushion to have a natural frequency of not less than 100 cpm. That means there will be no amplification of the vibration so far as the motion of the passenger on the cushion is concerned. Of course, the passenger at the point of support has the amplitude of the vehicle, regardless of damping.

The natural frequency of the unsprung masses is in the range of 10–12 cpm. If the passenger on the cushion has a natural frequency of 100 or 120 cpm, he is well isolated from the 10–12 cpm disturbances.

Damping is necessary, however, to take care of vibrations after a road bump. If there were no damping in the cushion, the passenger would tend to bounce freely. The damping has to be pretty good to keep frequency down to around 2 cps and amplitude to ¼ in., which are the human tolerances. Best type of damping is friction damping or a combination of friction and possibly air damping.

The passenger's mass is part of the vibrating system, too. Tests run at the University of Michigan showed that in a car running over a series of bumps, the passenger's head moved like the cracker on the end of a whip. The head weighs about 11 lb, and the neck just isn't very well built to carry it. The whip-snapping action may account for the neck

Experts participating in the discussion reported in the accompanying article are W. E. Lay, University of Michigan; R. N. Janeway, Chrysler; K. E. Coppock, Fisher Body; J. D. Caton, Stubnitz Greene Spring Corp.; H. E. Chesebrough, Chrysler; F. A. Hall, GMC Truck and Coach; and J. C. Gordon, Gordon-Chapman Co.

fatigue some people experience after a long, rough drive. It may also account for some of the eye fatigue, since people tend to keep their eyes focused at about the same level despite head movement.

Have we put too much luxury into the driver's seat?

Maybe so. Seating the driver in an overly luxurious seat is not conducive to keeping him alert—especially in cars equipped with automatic steering, automatic drives, and other effort-saving devices. Today's high speeds make it imperative that the driver stay wide awake and ready to react.

Maybe designers of passenger car seats could take a lesson from truck seats. Truck drivers like bucket seats with spring-less padded backs and fairly firm cushions. Pleasure car or truck, the driver needs to be seated comfortably, but not in a position so relaxed that drowsiness ensues, nor on a seat so hard that he is stiff when he gets out.

How important is showroom feel of the seat?

Passenger cars are used for a lot of things, but they are built for sale. You can't neglect showroom appeal. Final selection of a car is usually made by a woman, and women tend to be attracted by a seat with the feel of their overstuffed livingroom furniture.

It definitely is possible, however, to achieve reasonably soft showroom feel without destroying the desirable riding qualities. Surface softness seems to be what counts in showroom feel. A couple of inches of a soft material like feathers is enough to give softness over a firm supporting base.

Surface softness has, of course, more advantage than just showroom appeal. It allows the driver to sink down a little, which increases the area of support slightly and thereby decreases the unit pressure. The lower the unit pressure on certain muscles and nerves, the less the fatigue.

Diesel Research . . .

. . . is still a wide open field. MAN highly supercharged engine illustrates the gains possible when combustion chamber envelope problems are attacked.

Based on paper by **C. G. A. Rosen** Caterpillar Tractor Co.

IN the development of high output diesel engines, major attention has been focused on ways and means by which more air is made available to consume more fuel in given cylinder displacement. At the same time, too little attention has been given to effective means of heat extraction to critical parts and to lowering inherent losses of the piston engine system. In view of this, the development of the MAN highly supercharged engine is most significant.

Experiments with the MAN engine have shown a 300% increase in output with only a 30% increase in heat flow through the material of the combustion chamber and piston rings. Notable is the fuel consumption of 0.308 lb/bhp-hr at a bmep of 213 psi and an effective efficiency of 44.5% with substantial reduction in friction and thermal losses. Friction losses vary almost directly as the square of the compression ratio, a relationship found to be true in several designs of high output engines.

The new MAN engine is supercharged by a turboblower with five stages in an axial flow exhaust gas turbine and a nine-stage axial flow compressor discharging into an intercooler before the final radial flow stage after which the air is aftercooled. High supercharge efficiency is obtained and a maximum weight of air is delivered to each cylinder at the relatively low temperature of 80 F, which is extremely important in supercharging diesel engines.

Supercharging is a natural for the diesel engine because it thrives on excess air delivered at low temperature. However, progress in its wide adoption has been hampered by the inefficiency of the blower and the difficulty of matching properly the supercharger with the demands of the engine for air in proportion to the fuel delivered.

Temperature of the air delivered to the cylinder at the end of the suction or intake stroke influences the mean cyclic temperature substantially. The terminal temperature of compression is raised 3 to 3½ times the inlet air temperature, depending upon the compression ratio employed. There is a great difference in engine performance and maintenance if air is delivered at 80 F or at 270 F (typical in present day engines). At 80 F operation is successful; at 270 F there are thermal difficulties with pistons, rings, and valves.

There is great need for something new in pressure charging, of vast improvements in existent superchargers, to get the high outputs which customer demand will foster. An efficiently blown diesel should yield a minimum of at least 100% increase in output over a normal atmospherically aspirated engine. The MAN engine is exceptional, but it stands to reason that a five-stage turbine, ten-stage compressor and two intercoolers would not be tolerated on a supercharged automotive type diesel installation. (Paper, "A Survey of the Combustion Chamber Envelope," was presented at SAE Student Branch of Purdue University, Lafayette, Ind., March 20, 1952. It will be printed in full in SAE Transactions. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers).

1953 SAE Annual Meeting

. . . continued from page 18

FUELS . . .

. . . of the future will bring new vistas, new challenges to engineers.

SOME day petroleum and coal may be as archaic as an energy source as wood is today. Scientists now are working on fuels that would surpass Buck Rogers in his wildest flights of fancy. Flight powered by light emissions and electrical particles and nuclear energy powerplants were pointed to as distinct possibilities at the Annual Meeting.

Just as the Jules Verne science fiction is reality today, so will today's fantasia on space travel become the commonplace of tomorrow. Hardheaded scientists at the meeting said that these weird power sources have been worked out in theory. They look impossible only because scientific and engineering knowledge lags behind the theory.

But modern technology is piling up knowledge at an ever-increasing rate. Eventually practical know-how will catch up with long-haired theory.

Although engineers had their heads in the clouds on future fuels, they had both feet firmly planted on terra firma on current fuels. They still are searching for ways to improve gasoline. One approach, the addition of tricresyl phosphate as a spark-plug fouling preventative, attracted considerable interest.

"The Future of Atomic Energy in Industry"
by Walker L. Cisler, The Detroit Edison Co.

RIGHT now two things are holding up construction of stationary powerplants operating on nuclear fuels. They are:

1. The Atomic Energy Act of 1946 says that only the government can own fissionable materials and facilities for producing and using these materials.
2. It doesn't look as if the first installations can produce electric power at costs competitive with conventional generating methods.

To make atomic-generated power competitive with that from present fuels would take large reactors (units in which the atom is split and heat released). These reactors would have to turn out 100,000 to 200,000 kw. A 5000-kw unit would produce power for between 3 and 5¢ per kwh . . . a price justified only in remote, isolated locations.

At best it's unlikely that atomic-generated power will cost less than what the consumer is paying today. That's because atomic-fueled reactors, replacing the coal or oil-fired boilers, represent only 17 to 20% of total investment in a power system.

Key to lowered costs may lie in reactor products and byproducts—fission materials bred in the reactor. If these have any worth, and are credited to the reactor, electricity may cost less than present estimates.

There are educated guesses as to other places where industry may use atomic energy . . . from reduction of ores to heat treatment of parts. If low-cost heat could be produced from atomic fuels, coal could be converted to liquid fuels and made competitive with petroleum products.

Nuclear-fueled motor vehicles are not around the corner—even on paper. A passenger car reactor would need a critical mass of plutonium 1 or 2 ft in diameter, surrounded by a 6-ft-thick concrete shield. What's more, it wouldn't save much in fuel costs, since an average car burns no more than $1500 worth of gasoline in its life.

A new group of fission products, called "fips," may change this picture. They have remarkable properties, give off lots of heat, and can be handled more easily than plutonium.

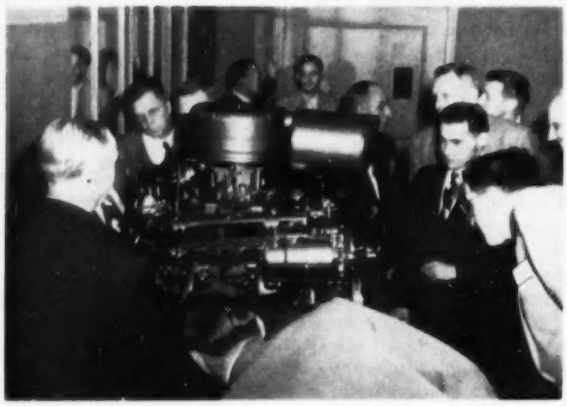
What would be the cost of power derived from nuclear fuels, asked SAE Past-President R. J. S. Pigott in the discussion. You could afford to spend $227 per kw in plant facilities as against $77 per kw for present type powerplants, replied Cisler. That's because fuel costs would be negligible with a nuclear power reactor.

However, a nuclear power reactor might have a shorter life than a conventional boiler installation and might have to be amortized over a shorter period.

Not included in the cost comparison is the possible sale of the byproduct plutonium from a breeder reactor.

Emil Gibian, of Thompson Products, asked how heat generated in the reactor would be carried to the boiler. Said Cisler, one way is to carry the fission-released heat by a liquid to a heat exchanger. The heat then would be carried away by another medium. These complexities

New Buick Engine Announced



Buick's new V-8 engine drew crowds at the session at which it was described

are needed to get around the radiation problems.

There's little concern over unavailability of atomic fuel, advised Cisler. On a Btu basis, there are 23 times more fissionable materials known to be available in the world than the total of the known reserves of solid, liquid, and gaseous fuels. Or, saying it another way, there are more than 1000 years of conventional fuels known to be available, and more than 23,000 years of nuclear fuels attainable from the earth's surface.

"The Dawn of Aviation's New Era" by D. G. Samaras, Wright Air Development Center, U. S. Air Force

ENERGY without heat will propel airplanes of the future. Charged electrical particles or even light emission will furnish thrust for flight. The new techniques will bypass the high energy or heat losses from converting chemical and nuclear energy to mechanical energy.

An example of a nonthermal propulsion system is the proposed "Ionic Rocket." This jet propulsion system would convert electrical potential directly into accelerated particles. So the rocket would be propelled by electrostatic acceleration of ions.

This system would eliminate the heat cycle with its low thermodynamic efficiency. But it would bring many new complicated problems.

Particle speeds possible with this system are much higher than those from expansion of heated gases. So very high thrusts per unit of mass flow can be achieved. And conversion of electrical into kinetic energy may be 90% efficient. (Current propulsion systems, for ground vehicles or aircraft, aren't expected to ever be more than 50% efficient.)

The nonthermal propulsion system will have to await:

1. The discovery of a high-intensity source of low mass ions.
2. The development of a transportable source of electric power.

The ideal setup for an ionic rocket would consist of direct conversion of nuclear into electrical power, with simultaneous formation of ions. An ionic rocket patent granted to E. G. Linder, of Radio Corp. of America, uses a static potential built up by alpha and beta-emitting substances. The charge is drained at a rate up to the emission rate of the quantity of radioactive material used.

Another possible nonthermal propulsion system is typified by the photon rocket. This device gets its thrust from the reaction force of light emission. Limitations of present materials and power sources make this system far from practical. The heated plate from which light is emitted must be kept at something like one million degrees to produce enough thrust to lift a useful payload. And the power source would exceed that of all generators in the United States.

"Service Experience with TCP Additive" by C. E. Johnson and D. N. Harris, Shell Oil Co.

A PINCH of TCP (tricresyl phosphate) added to aviation fuels can help reduce spark-plug fouling. That's what service tests with both military and commercial aircraft have shown.

All things considered, best TCP scavenger composition seems to be 1.0/0.1. It's more advantageous in some equipment than others in reducing fouling tendencies without bringing adverse secondary effects.

For example, you can't use TCP indiscriminately in all planes equipped with exhaust turbos.

TCP also is effective as a fouling inhibitor in operations using extreme manual leaning. Both military and commercial operators are rapidly trending in that direction to reduce fuel consumption. Another thing that these service tests show is this: The greater the trouble with spark-plug fouling, the more the help that can be expected from TCP.

Information to date with TCP points up the merit of continuing investigation of the additive.

In discussion, an engine man described an instrumentation scheme for observing spark-plug performance. This system, which permits cycle-by-cycle analysis, is already in use by airlines studying spark-plug fouling, another

discusser reported. It has permitted the broad conclusion to be drawn that tricresyl phosphate results in a 30% decrease in plug fouling and a 7% reduction in cylinder removal.

ENGINES . . .

. . . stick to high compression in U.S., aircooling in Europe, but may assume new roles in helicopters.

ENGINES of both American and European vintage formed the common denominator for a lot of thoughts exchanged at the meeting. Just about every engineer in attendance at one time or another expressed an opinion, shared an idea, or asked a question about some facet of present-day engines. Some waxed hot and heavy on design; others found applications a livelier and more provocative subject.

A description of Buick's new 8.5 to 1 compression ratio engine served notice that American designers are still excited over this design approach to better economy. Emphasis, too, continues to be put on reducing diesel engine cost, size, and weight . . . and improving fuel injection equipment. Europeans, on the other hand, are running a fever over results achieved with aircooled engines.

Is it to be piston engines or gas turbines for helicopters—and, if turbines, what kind? These two queries proved irresistable bait to another segment of engineers. They latched onto them . . . and didn't let go until the entire present and future outlook had taken shape.

"New Buick V-8 Engine" by V. P. Mathews and J. D. Turlay, Buick Motor Division, General Motors Corp.

BUICK's new valve-in-head V-8 engine develops 188 bhp at the highest compression ratio in present-day gasoline engines—8.5 to 1. Yet it has a stroke of only 3.2 in. to go with its bore of 4 in. and piston displacement of 322 cu in. Low stroke-bore ratio, for that matter, helps make this V-8 more than 1 ft shorter and 170 lb lighter than its in-line eight predecessor.

The engine encompasses a variety of other new features too. Here are a few:

- Cone-shaped combustion chambers have spark plugs located in dead center at the top. This reduces the distance the flame has to travel, permitting high compression operation with currently available premium fuels.
- A vertical valve arrangement with both intake and exhaust valves on the same side of the combustion chamber.
- Cam-turned counterweights on the crankshaft which make possible a compact, lighter engine.
- A 12-v electrical system.

In the ensuing discussion, the specific reasoning behind the choice of the cone-shaped combustion chamber was explained: it offered the best mechanical octane number of many shapes tested.

Petroleum men expressed admiration—and some concern—with the 8.5 to 1 compression ratio of the engine. And one questioner learned to his surprise that styling departments really do exert a tremendous influence in design of today's engines . . . that space requirements set by them are a foremost consideration.

"Contemporary European Aircooled Diesel Engine Practice" by Wayne H. Worthington, John Deere Waterloo Tractor Works.

AIRCOOLED diesel engines are being successfully built in Europe to meet a wide variety of automotive

Diesel Fuel Miser

Makers of the new Roosa-Master fuel injection pump for diesels described their device in a paper read at the meeting

and industrial uses. Cooling problems have been solved so satisfactorily, in fact, that:

1. Specific output and specific fuel consumption are comparable to those of similar combustion systems in watercooled engines.
2. Wear rate is less than that of liquid-cooled engines when operated on fuels of equal grade and quality.
3. Overall length and height dimensions can be maintained equal to or less than those of liquid-cooled engines of equal displacement when the space requirement of the radiator is included.
4. Cold weather starting characteristics compare favorably with those of liquid-cooled engines.

To achieve these results, European builders have, with one exception, used a 4-cycle engine. In most respects, however, the similarity between various makes of engines ends here.

Cooling systems, for example, are different for almost every engine. And combustion chambers appear in a variety of shapes—both offset to the side of the cylinder and built into the piston or cylinder head.

"The Volkswagen Aircooled Engine" by Ludwig C. Boehner, Chief Engineer, Volkswagen Co.

SINCE its inception in 1934, the 4-cycle, 4-cyl, aircooled engine used in the Volkswagen passenger car has undergone many changes. Among other things, stroke capacity and specific power have been increased, further complicating the job of engine cooling and noise control. Development work, however, has eliminated to a great extent these disadvantages of aircooled engines as compared to watercooled ones.

Measures taken to improve engine cooling were intended to (1) prevent overcooling in winter, especially on down grades; and (2) to equalize temperatures of the cylinders and cylinder heads, prevent local temperature peaks, and overheating of the engine in general. And they did! Foremost component in the system that brought about these results was a thermostatic control that makes use of the throttling principle.

Other changes helped to bring the engine closer to the noise level of watercooled engines with their noise-dampening water jackets. Use of "autothermic" pistons, which permit slight structural play without siezing, reduced piston noise. Reinforcing ribs increased rigidity of the powerplant casing. And sound dampeners cut transmission of sound through solid parts.

"General Motors 'Model 51' Diesel Engine" by John Dickson and Roger D. Wellington, Detroit Diesel Engine Division, General Motors Corp.

GENERAL Motors' new Model 51 diesel engine is the latest effort to reduce cost, size, and weight of diesel engines for automotive, marine, and industrial work. It doesn't hit the bulls-eyes of all of these elusive targets, but at least it's a case of firing in the right direction.

Weight of this two-cycle, loop-scavenged, high-speed diesel engine, while an improvement over previous models, still leaves something to be desired. Demand and extent of tooling will determine how close the engine comes to meeting the cost goal set up for it. But it does fulfill power specifications, *without exceeding the size its designers had in mind.*

The inherent simplicity of this loop-scavenged engine—made possible by complete lack of valves and valve gear—was emphasized in discussion. Several discussers felt, however, that the camshaft might well have been eliminated too. The authors explained that the camshaft was retained in the engine primarily to act as a balance shaft. But that in this role, it also provided the cheapest way to drive the unit injector and supply a galley for the lubricating oil system.

Another member of the audience reported that Navy tests had shown the cold-starting characteristics of the engine to be as good or better than most other small engines.

"Simplifying Fuel Injection" by Vernon Roosa, Hartford Machine Screw Co., Inc.

THE new Roosa-Master fuel injection pump is made up of four basic working elements: a fuel-supply-tank-to-injector positive displacement pump, a metering valve, a distributor rotor, and a single-cylinder, opposed-plunger fuel injection pump.

Fuel drawn in at the top of the unit by the fuel transfer pump flows under pressure down through the metering valve. From this point, it enters the distributor rotor when one of the charging parts in the rotor comes into register with the passage from the metering valve. Next, it passes down an axial passage in the rotor to the cylinder containing the two opposed plungers. There, the plungers are forced outward in proportion to the quantity being injected. Further rotation of the rotor causes the outlet port of the rotor to come into register with one of the fuel line connections in the hydraulic head. At this time, a cam arrangement forces the pump plungers together, causing the fuel to be ejected up and out of the unit.

Calibration, therefore, is inherent in these units

for time relationships and sequence of the various functions are set during manufacture. This, together with the fact that dribble is eliminated by the sharp cut-off of injection, makes good economy possible.

What's more, units made for 2-, 3-, 4-, 6-, and 8-cyl diesel engines can operate in any position, clockwise or counterclockwise.

In the discussion period following presentation of this paper, the author was asked several times to explain how the fuel injector is able to match various engine torque curves. Other questioners wondered what range of timing can be obtained with the unit, how the cams are manufactured, and whether the rollers fully follow the cam.

"The Selection and Evaluation of Powerplants for Helicopters" by E. F. Katzenberger and H. J. Nozick, Sikorsky Aircraft Division, United Aircraft Corp.

RIGHT now the primary source of power in the large majority of helicopters is the reciprocating engine, but the turboprop engine is coming up fast.

This infant still has some growing pains to go through—yet even now it is superior in some ways to its piston-equipped relative. Not only is it lighter and simpler in construction, but it's also cleaner aerodynamically.

What's more, even in their present stage of development, turboprops can handle some helicopter missions as well if not better than reciprocating engines . . . (see below)

"Matching the Characteristics of Helicopters and Shaft Turbines" by D. N. Meyers and Z. M. Ciolkosz, Piasecki Helicopter Corp.

ALREADY gas turbines are suitable powerplants for many helicopter operations. But continuing improvements in specific weight and specific fuel consumption will enable them to handle these jobs even better . . . and take on new ones as well.

Whether turbines are selected for various helicopter applications depends almost entirely on fuel consumption characteristics of these powerplants. If missions call for high cruising speeds, rapid climbing rates, or hovering—in short, any operation which demands power approaching maximum continuous rating—then turbines are a likely choice. That's because their specific fuel consumption is comparable to piston engines under these conditions. Where missions require cruising at minimum power or place emphasis on endurance time rather than range, poor part-load fuel economy weighs heavily against selection of turbines.

Much can be done, however, to overcome this part-load deficiency of shaft turbines. One possible solution would be to use two or more small turbines instead of one large one. In this way, one engine can be shut down and the other operated economically at or near maximum continuous power.

Still another approach would be to design the helicopter so that it could fly at a speed fast enough to absorb the full installed horsepower.

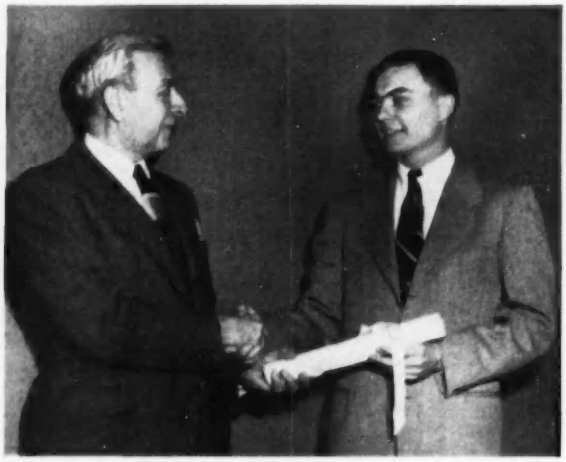
A third possible method of attack would be to design compressor and turbine for peak efficiency at part load so that specific fuel consumption would be improved . . . even at the expense of decreased efficiency at take-off power.

Actually, so many variables are involved it is

LM to Zeder

James C. Zeder, 1950 SAE President, (right) is presented with a Life Membership on the occasion of completing his term on the SAE Council as a Past-President. Presentation was made by 1952 SAE President D. P. Barnard

Wins Horning Award



L. F. Dumont, of E. I. duPont, (right) was presented the Horning Memorial Award by 1952 SAE President D. P. Barnard

Dumont received the award for his 1951 SAE Summer Meeting paper "Possible Mechanisms by which Combustion Chamber Deposits Accumulate and Influence Knock"

difficult to predict improvement trends in turbine performance. However, reduction of specific weight will probably progress more rapidly than reduction in specific fuel consumption.

"Design Considerations for a Helicopter Gas Turbine Powerplant" by J. L. Koetting, Project Engineer, Solar Aircraft Co.

A GAS TURBINE with a mechanically-free power section would make a far better helicopter powerplant than one with the power unit mechanically connected to the other turbine elements. Why? There are many reasons—all traceable to the lack of physical connection between the turbine stage (or stages) which provide power and those which drive the compressor and accessories. Here are a few:

1. Less power required to start. Only the compressor and gas-producer (compressor-driving) turbines would be rotated in the starting cycle, thus eliminating drag of the power turbine and main reduction gear.

2. Vibration and rapid load changes would not be transmitted back to the gas-producer section and the accessory-drive gear box.

3. Simplified and lighter installation, since there would be no need for the conventional mechanical slip clutch.

4. Greater flexibility of operation because the power turbine can operate over a range of loads and speeds without changing the gas-producer turbine operating point. The control system for this powerplant, therefore, is markedly simplified because the governor on the gas producer need only meter fuel to maintain a constant speed.

5. Torque increases with decreasing power turbine speed. When there is a speed decrease resulting from a sudden load, this characteristic will give faster speed recovery.

"Characteristics of the Two-Shaft Gas Turbine in Helicopters" by William B. Anderson, Boeing Airplane Co.

THE two-shaft gas turbine has much to offer the helicopter designer in his search for a more suitable powerplant. Briefly, the advantages to be gained by using two-shaft turbines in rotary-wing aircraft are:

1. Nearly full-shaft power over the useful range of rotor rpm and an increasing torque with decreasing rpm characteristic. These, in turn, provide rotor rpm stability, better handling qualities, and improved control.

2. Increased payload and/or performance—thanks to a lightweight powerplant and an installation made lighter by no clutch, cooling fans, and special cowls.

3. Improved flight performance, including hovering, rate of climb, and operation at higher altitudes.

4. Ability to burn cheaper grades of fuel which simplifies logistics and lessens fire hazard. (It also compensates somewhat for high fuel consumption of the engine.)

5. More crew comfort by reduction of noise level and elimination of engine vibration.

Actually, however, the full possibilities of the two-shaft turbine in helicopters can be completely explored only by further flight evaluation. In the meantime, reliability is being increased and fuel consumption decreased.

"The Reciprocating Engine in the Helicopter" by J. J. Shields and J. T. Bowling, Continental Aviation and Engineering Corp.

ADAPTING typical aircraft reciprocating engines to helicopters was not the simple job it was thought it might be. Many changes and additions—some

radical, some incidental—had to be made to get light, compact, accessible, well-cooled powerplants that could meet the rugged performance schedule of helicopters.

It was found expedient, for example, to mount engines vertically or nearly vertically. This necessitated that breathing facilities be rearranged, oil seals made to operate under a head of oil, and magnetos with impulse couplings—normally operated with gravity-actuated flyweights—be spring-loaded to operate with vertical shafts.

With weight a vital consideration in helicopters, every effort also had to be made to minimize or eliminate the flywheel as such. Where transmissions were mounted remotely from the engine crankcase, the cooling fan was employed as a flywheel to good advantage. With the transmission mounted on top of the crankcase, the portion of the clutch rigidly attached to the crankshaft was made to serve as the flywheel.

Engine cooling presented special problems, too. While fixed-wing aircraft make use of forward mo-

Around the Meeting. . . .

Harry Chesebrough

Next January at the 1954 SAE Annual Meeting, the sessions, committee meetings, and other activities will be spread over the Hotel Statler as well as the Sheraton-Cadillac. Meetings Chairman **Harry Chesebrough** got Council approval for his Committee's decision on the last day of the 1953 Annual Meeting. New highs in total attendance, session attendance, and committee meeting attendance definitely require added facilities, Chesebrough reported.

The annual business session of the Society was held preceding the technical session on Tuesday evening, January 13. Proposed amendments to the SAE Constitution were read by Constitution Committee Chairman George McCain and it was voted to submit the amendments to mail ballot of the voting members. (The proposed changes were printed in detail in the November SAE Journal.)

Latest British jet planes cavorted to the tune of a hot jazz trio in Shell Oil's film "Highlights of Farnborough—1952" shown at the Thursday evening session. Close-ups showed a D.H 110 like the one which disintegrated during the show, killing DeHavilland test pilot John Derry. Other shots showed the Hunter, Meteor, Swift, Valient, Javelin, and others in maneuvers and supersonic flight.

THREE PAPERS presented by title only at the meeting were:

"Automatic Control Systems Satisfying Certain General Criteria on Transient Behavior" by A. S. Boksenbom and R. Hood of NACA Lewis Laboratory.

"Friction Properties of Synthetic Lubricants Suitable for Aircraft Turbine Engines" by R. L. Johnson, M. Swikert, and E. E. Bisson of NACA Lewis Laboratory.

"The Effect of Combustion Time on Knock in a Spark-Ignition Engine" by D. R. Diggs of E. I. duPont de Nemours and Co., Inc.

These papers, like those regularly presented, are available in multilithographed form at 25¢ each to members and 50¢ each to nonmembers. Address your orders to the SAE Special Publications Department, 29 West 39th St., New York 18, N. Y.

Harold Puxon

Harold Puxon, managing director, Columbia Trailer Co., Ltd., of Vancouver, came to Detroit and carried to all parts of the Annual Meeting an alluring prospectus of the SAE International West Coast Meeting. It's scheduled to be at the Georgia Hotel in Vancouver the 17th through 19th of August. His descriptions of the promised social and technical fare made many turn their vacation longings toward the Canadian Northwest.

The President Meets the Press

Robert Cass, 1953 SAE President, held a press conference Tuesday afternoon just prior to the announcement of his election. Declining to make "guesstimates" of future automotive production, he commented: ". . . a statistic is just a figure with a chip on its shoulder. There are no friendly statistics."

Twice a day, throughout the meeting, the SAE Press Room at the Sheraton-Cadillac was the scene of conferences with SAE authors.

tion to move cooling air, helicopter cooling systems get no such assist. Axial flow fans, exhaust ejectors, or combinations of both had to be used to impart motion to the cooling air . . . and optimum entrance conditions are seldom attained in buried engine installations.

More food for thought on the subject of piston versus turbine engines for helicopters came out in the discussion period.

One engineer noted that a recently developed piston engine is 100 lb lighter than many conventional reciprocating engines. It has no camshaft, cam rods, flywheel, dampers, and counterweights . . . and no vibration, he reported.

In answer to a query from the floor about what improvement can be expected in the overhaul period of turbine engines, Anderson replied that 100 to 150 hr might be added to the present 300 hr in a year or so.

Another questioner wanted to know whether it would be possible to shut down one turbine engine and start up another in a multi-engine commercial helicopter. He, in turn, was told by Meyers that where altitudes are 3000 ft or over, this would be quite safe—since the cold engine could be started in 30 sec—long before too much altitude was lost.

Others in the audience found out more about the state of the art of linking two or more turbine engines, the possibilities of using water-alcohol injection to augment power, and what clutch mechanisms are needed with turbine engines.

"Helicopter Power Requirements Necessitate Tight Limits on Engine Power Controls" by Robert Bradham and John S. Kerr, Helicopter Division, Bell Aircraft Corp.

HELICOPTER pilots just can't devote much attention to engine or rotor instruments when flying close to the ground. During this all-important phase of rotary-wing aircraft missions, they've got to focus their thoughts on the position of the ship. Thus the cry went out for a virtually automatic means for maintaining constant rotor rpm during

maneuvering . . . and designers came up with several.

Basically, these systems work on one principle: Throttle position is coordinated with rotor blade pitch so that the rotor power required at constant rpm and various pitch settings is always equal to engine output.

Several methods are employed to obtain this throttle-pitch coordination. Mechanical linkages do an effective job and are often used. A pure servo system also does a good job, but weightwise and costwise it can only be justified when missions are long or accurate pinpoint hovering is necesary.

NEW MATERIALS . . .

. . . still elude prediction. You can't tell if they'll work until you try them.

EXPERIENCE still is the best teacher when it comes to using new engineering materials. Even though metallurgists and materials men are pinpointing properties of new materials faster than ever before, each application is a case unto itself. That's what came out of sessions on titanium, ductile iron, and fiberglas-reinforced plastic.

Take titanium. In the few years since its advent, flocks of data have emerged from research labs on its physical and mechanical properties, corrosion resistance, and machinability. But every time an aircraft company tries it in a part, unexpected bugs crop up. Often designs have to be modified to live within the material's peculiarities. And manufacturing departments have to find suitable fabricating methods, often resorting to cut-and-try methods.

Ground vehicle makers and producers of other products have had the same experience with nodular iron and reinforced plastics, according to reports at the meeting.

But there's a bright note in the picture for all three materials. More and more people are using them. More and more facts about the materials are being swapped at meetings such as the SAE Annual Meeting. And they're working their way into production parts at an accelerated rate.

"The Bases for Tonnage Titanium Production" by C. I. Bradford, Rem-Cru Titanium, Inc.

TITANIUM has reached the point where its production now is measured in tons instead of pounds. What's more, titanium production is climbing at an ever increasing rate.

Titanium giants of 1952, 1200-lb ingots, are pygmies today. Rem-Cru now is producing 2-ton ingots. Incidentally, there's $20,000 worth of metal in each.

Both DuPont and Titanium Metals Corp., the two main producers of pure ductile titanium sponge, have been turning the stuff out at about the rate of 4 tons per day. And Rem-Cru melting production, for example, has averaged more than 2 tons per day.

This picture is quickly changing. Right now plants are under construction at Newport, Del. and Henderson, Nevada. That'll raise the production level to 20 tons per day, or 7000 tons per year. The Defense Department is taking steps to increase this level to 22,000 tons annually by 1955.

Melting capacity at Rem-Cru and elsewhere is in excess of sponge capacity. For example, Rem-Cru has had a melting capacity of 5 tons per day available since the last quarter of 1952.

When titanium becomes competitive pricewise with other structural materials, there's no telling how high production will go to meet the demand.

"Titanium Alloy Development" by M. Hansen and D. D. Kessler, Armour Research Foundation, Illinois Institute of Technology

RESEARCH now under way will eventually produce titanium alloys overcoming the limitations of current ones, particularly low ductility and heat resistance.

Some present titanium-base alloys have strengths up to 180,000 psi. But low ductility usually accompanies higher strength. Forming and welding problems also tend to reduce the acceptability of the stronger alloys.

New processing techniques will help hurdle some of these obstacles. Superior alloys will overcome other problems. These alloys will come from development based on:

1. A knowledge of the equilibrium phase relationships of titanium with other metals, and
2. Information regarding the kinetics of reactions in the solid state.

Titanium's aptitude for aircraft use also will grow when it can be made to withstand higher temperatures. It's appealing as a replacement for aluminum alloys and stainless steel parts in gas turbines.

Wright Air Development Center is sponsoring an investigation at Armour Research Foundation aimed at developing the material for high-temperature uses. It has been found that some titanium alloys show better creep rupture properties at tem-

peratures up to 550 C than types 304 and 403 stainless steel.

"Utilization of Titanium and Other Alloys in Corrosive Environments" by W. Lee Williams, U. S. Naval Engineering Experiment Station.

TITANIUM can hold its own with any material when it comes to corrosion resistance. But when it's used with other materials, galvanic corrosion can show up. There are ways of preventing galvanic corrosion. For example:

1. Select combinations of metals as close together as possible in the galvanic series. Titanium and stainless type 304 are okay; but coupling titanium and aluminum can be disastrous to the aluminum.
2. Avoid combinations where the area of the less noble material is relatively small. You'll get joint failures much faster with copper rivets in titanium plates than with titanium rivets in copper plates.
3. Insulate dissimilar metals where practical.
4. Apply coatings on exposed surfaces with caution.
5. Avoid joining dissimilar metals with threaded joints, if possible. Threads are likely to deteriorate rapidly.
6. If galvanic corrosion can't be prevented, install a replaceable waster piece. A replaceable section of a less noble metal localizes the attack.

"Titanium Alloys for Aircraft Engine Forgings" by L. R. Frazier, General Electric Co.

TITANIUM in low, medium, and high strength alloys is suitable for aircraft engine forgings. Each alloy works best in certain parts.

The low-strength alloys are produced by melting sponge titanium without further additions. These materials occasionally are used for forged or rolled parts not requiring high strength. They have been used for forged parts for welding to sheet metal parts. (Higher strength alloys don't lend themselves to welding.)

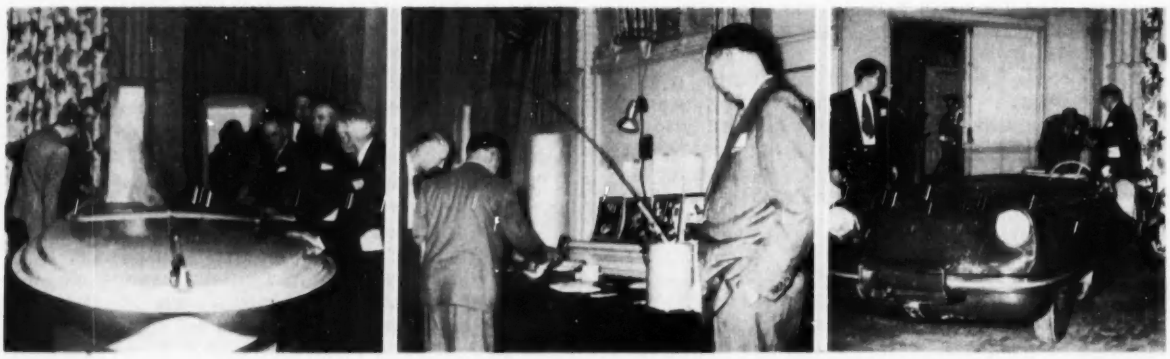
Low-strength titanium also works well in bearing housings. That's because these parts require intricate machining and precision grinding, operations fairly easy to perform on these alloys.

Most titanium forgings are made from medium-strength titanium, which is made by adding metal and interstitial elements. These alloys have a better balance of properties than either the low- or high-strength alloys. Strength is high enough for good strength advantage over other materials. The material is ductile enough to adjust itself to stress patterns produced at high stress levels. Hardness is within the range of practical machining.

High-strength titanium alloys contain larger quantities of metal additions. One of these alloys, with 3% aluminum and 5% chromium, has a superior strength-density ratio. It's most useful in nonrotating forged parts calling for high yield strengths, such as landing gear forgings.

The forgeability of all three forging alloys is about equal. None has any marked advantage over the others in scaling. All must be limited in heating

New Jobs for Plastics and Glass



Boats, fishing rods, and car bodies are just a few of the more than 100 items made of plastic-reinforced Fiberglas displayed at the meeting

time to prevent formation of a hard, brittle crust under the scale. All are subject to surface imperfections which must be removed before finish forging. And the same defects may be found in bars and billets of each of the titanium forging alloys.

"Titanium in Airframes" by F. Robert Kostoch, North American Aviation, Inc.

THERE is still much to learn about fabricating titanium. Because the material is so expensive, North American has been learning as it goes along in production and has held down experimental work.

Here are a few of the manufacturing problems North American has run into with titanium:

- Much sheet stock bends satisfactorily from one surface, but fails when bent from the other. Presumably one side of the sheet has absorbed more oxygen or nitrogen than the other during pack rolling.
- Titanium will stretch well, but does not shrink readily. Often, it'll buckle instead of shrinking. Using greater unit pressure or hot forming should get around the buckling.
- The material doesn't like to be pushed around rapidly. It is much easier to form titanium by stretching, hydropress or hydroform, and draw pressing than by punch press and drop hammer.
- We have yet to develop a reliable production method for fusion or resistance welding the alloy. The welded joints are brittle. Post-heating brings back some ductility, but not enough; and it's not easy to do in production.

One big problem with titanium today is making use of machine shop scrap, observed Phil DeHuff, of Westinghouse. He asked what's being done about it.

He was told that the big problem is in remelting. First, you can't tolerate impurities, including oxygen and nitrogen. Second, with present titanium melting techniques, shallow puddles are being melted so that it's tough to remelt large quantities of scrap. Third, you have to be careful that the scrap is really melted, not just cemented into the material.

Right now the scrap is being piled up. Materials suppliers are buying it for about $1 per lb in lots of 1000 lb or more. In the future much more of it will be used.

Interest ran high in the titanium price situation. Right now the material costs about $10 per lb in forgings, and up to $20 per lb in sheet. It's expected that these prices will be halved by 1955.

Ray Kelly, of United Air Lines, asked when titanium would be making its way into commercial planes. He was told that Douglas already has used about 450 lb in each of several DC-7's it's building for the Dutch KLM lines. Fred Moskovics warned against expecting too much progress here. First, military needs far exceed anticipated output for quite a few years. Then too, the price situation will have to improve before titanium can be considered economical for broad use in commercial aircraft.

Those close to titanium said that intensive development is going on . . . in heat treatment, surface treatments for wear resistance, casting, sponge quality improvement, and chrome plating. Progress is being made, but in most cases little can be said because some of the research is confidential. Most materials men at the meeting seemed to agree that major hardships with titanium come not from shortcomings of the material, but lack of knowledge about its properties and characteristics.

"Problems, Production, and Techniques of Laminated Fiberglas" by I. M. Scott, Winner Mfg. Co.

RIGHT now there is much interest in the automotive industry in glass-reinforced plastic laminates for car bodies. Many of their properties make these materials attractive for this use. But much remains to be learned before the automotive industry seriously considers plastic car bodies.

An outstanding property of resin-glass laminates is high strength-weight ratio. The material is noncorrosive. Large parts can be molded of it. And color can be molded right in.

The material can withstand rain, sun, frost, and snow without crazing, cracking, or warping. Some combinations of glass and resin can take heat up to 500 F. The stuff is a good electrical insulator, it's translucent, it needs no paint. And it can be made resistant to acids, alkalis, oil, gasoline, and corrosive gases.

Reinforced plastic has been fabricated into fishing rods, corrugated sheet, pipe, radomes, boats, tanks for chemicals, luggage, and aircraft radomes. For automotive use, many questions remain unanswered. For example:

- How should the parts be designed?
- What kind of glass and polyester resin should be used?
- How should the materials be fabricated?

Symposium—Wear and Surface Treatments to Prevent Wear

"The Mechanism of Wear" by W. E. Jominy, Chrysler Corp.

THE specialists generally agree as to the causes of wear of parts such as piston rings, cylinders, pistons, tappets, valves, bearings, and other mating parts. But it is not possible to make sweeping

generalizations about the mechanism of wear.

It is pretty well agreed that these are the causes of wear:

1. Lack of an oily type lubricant.
2. Load. Beyond a certain critical load, wear occurs very fast.
3. Abrasion and corrosion.
4. Other contributing causes, such as speed of travel between wear surfaces, composition, hardness, microstructure, and surface finish.

Wear behavior itself is a pretty complicated phenomenon. Any statement made about it may be true or false, depending on other complications.

You are pretty safe when you say that slow wear produces very fine particles and fast wear, coarse particles. That's because tests followed up by electron microscope examinations have shown this.

The products of corrosive wear usually protect metal, or at least slow down attack because of the interface. But if this interface is loose enough to be wiped off during the wear process, corrosion proceeds at a faster rate. The somewhat abrasive corrosion products also hasten wear.

One researcher has suggested that wear is inversely proportional to hardness. There are many cases where this is true. A host of exceptions pop up to the formula expressing this generalization. These exceptions generally can be explained away after finding the particular wear behavior involved.

For example, a babbit bearing—though very soft—will not wear much when run against a much harder steel shaft, which does wear appreciably. It's believed that the shaft wear stems from abrasive particles, which lodge in the babbit and act as a lap.

Often changes in microstructure account for a difference in behavior contrary to that expected from hardness. It's particularly true in comparing cast iron and steel. Cast iron resists galling much more than steel of equal hardness. Evaluating composition and microstructure with hardness probably will yield good relationship with wear. But it is not possible to formulate a mathematical relationship between microstructure, hardness, and wear.

Nor is there a hard and fast rule as to composition of metal for wear resistance. In steel, high hardness with high carbon gives best results for common wear. With cast iron, hard particles such as iron carbides give good service.

"Wear Characteristics of Magnesium" by E. L. Schaper, The Dow Chemical Co.

CERTAIN magnesium alloys do an acceptable job in wearing parts, such as bearings, when properly heat treated. New coatings are giving magnesium even greater wear resistance.

Certain cadmium, lead, and tin alloys of magnesium have been investigated for bearings and found fairly successful. Under high loads, certain precautions had to be taken. Lightly-loaded magnesium bearings now are being used in electric motors and textile machinery. They also have been used in the German automotive and aviation industries.

Lots of other wear applications can be cited for magnesium . . . foundry elevator buckets, core boxes, grain scoops, and lawn mower gears.

For really tough wear jobs, magnesium can be given any one of several coatings.

Chrome-plated magnesium printing plates give press runs up to 20 times longer than those from copper-faced electrotypes. Several anodic coatings also give good protection against wear. A new electro-chemical coating, called HAE, is hard enough to scratch glass. It can withstand corrosion, heat, and abrasion.

Sprayed metal coatings have been tried, although they often cost more than plating. One of the latest is a chromium-tungsten spray.

"Wear Resistant Coatings for Ferrous Materials" by R. H. Bancroft, Perfect Circle Corp.

ELECTROPLATED chromium makes a fine wear resistant coating because it combines high hardness with elasticity.

On piston rings, the trend is toward chromium plating. Deposited on cylinder liners, chrome plate has been responsible for low wear rates.

The British insist that the main reason for chrome plating piston rings is to protect the cylinder liner. They report a two to one improvement of life of plain liners in diesels, and a four to one improvement in gasoline engines by using solid chrome plated rings.

In this country the chief reason for chrome plating rings is to give initial scuffing protection and for long ring life. In only a few cases does longer bore life seem to be the reason behind chrome plating. Tests pretty much bear out the main claims for chrome, and point up other interesting results too.

In one test, half the top rings of an engine were chrome plated and the other half Ferroxed. Second groove rings all were Ferroxed. After 44,881 miles of heavy driving, average end clearance wear on the top unplated rings were four and one third times as much as that on the plated rings.

But what's interesting is this: There is little if any improvement in wear resistance of the second

At Pre-Dinner Reception

Left to right

1. In foreground: A. W. Phelps and SAE Past-President J. H. Hunt. In background: SAE Past-President Dale Roeder, SAE Councilor R. Wayne Goodale, and SAE Past-President D. P. Barnard

2. Thomas A. Farrell, Dearborn Motors; A. W. Phelps, Oliver Corp.; and Ernest R. Breech, Ford Motor Co.

3. SAE Past-Presidents W. S. James and Ralph R. Teetor

4. Lt.-Gen. Orville Cook and SAE Past-President Arthur Nutt

5. R. K. Clifford, Continental Steel Corp.; W. W. Sebald, Armco Steel Corp.; Admiral Ben Moreell, Jones & Laughlin Steel Corp.; Roy H. Davis, Atlas Steels, Ltd.; B. E. Hutchinson, Chrysler Corp., and M. K. Schnurr, Rotary Electric Steel Co.

6. Past SAE Materials Vice-President V. A. Crosby (in background at left); L. C. Burkey, Jones & Laughlin Steel Corp.; and Major-Gen. Floyd L. Parks

groove rings on the same piston under the chrome top rings. This has happened so many times that it's become an accepted fact.

Tests also show that the wear rate of both top chrome rings or relatively unprotected second rings is a function of how fast the miles are put on . . . and apparently the faster the better. Stable chromium film wear is reached after 10,000 miles of travel or after a travel rate of over 2500 miles per month. It seems to reach an optimum of about 0.00002 in. per 1000 miles.

"Lubricants—the Surface Saver" by J. F. Kunc, Jr., and J. P. Hamer, Esso Laboratories, Research Division, Standard Oil Development Co.

FOUR major type lubricants go into motor vehicles —engine oils, transmission oils, rear axle oils, and greases. Each faces a different problem in doing its wear-prevention job.

Prime requisites for each lubricant are:

1. For engine oils . . . proper oil viscosity and viscosity index.
2. For transmission or gear lubes . . . pressure-viscosity characteristics are important in preventing surface failure. Automatic transmission fluids must permit good friction coefficients between steel and friction band materials.
3. For hypoid gear lubes . . . mineral oils must be fortified with additives which will react chemically with gear surfaces to form solid film lubricants.
4. For greases . . . the lubricant must be able to overcome fretting of automotive mechanisms.

Progress with engine oils has been made by additive additions rather than by changing refining techniques. Detergent-inhibitor additives have reduced engine deposits as well as wear.

With more compact automotive engines in the works for the future, temperatures and pressures on engine lubes are bound to be greater. Needed improvements in crankcase oils will come from chemical additives or synthetic base oils rather than through further refinement of mineral oil base stocks.

In transmissions, conventional designs impose light loads on gears. So conventional mineral oils do an adequate lubricating job. Proper lube viscosity under high pressures will prevent wear, scoring, galling, or other surface failure of gear teeth.

Extreme pressures to which hypoid gears are subjected call for a special property in the lube. Some chemical compound has to be added to the mineral oil. This chemical forms a solid film lube on the steel surface. Phosphorus, sulfur, chlorine, and lead compounds are used as additives in extreme pressure gear lubes.

Most greases consist of a mineral oil thickened with a soap. Certain components—such as wheel bearings—need a better grease structure than parts such as shackles. To prevent misapplication at the service station, interest has been shown in multi-purpose greases. Only trouble here is that these greases cost more. The service station operator doesn't want to pay the extra price, particularly when most of his business requires only lower priced grease.

"Aluminum Finishes that Resist Wear and Erosion" by R. V. Vanden Berg, Alcoa Process Development Laboratories, Aluminum Co. of America

HARD skin given to aluminum by new coatings permits aluminum parts to stand the gaff of pretty severe wear and corrosion.

Treatments such as the Alumilite hard coating and the Martin hard coating make aluminum suitable for jobs often given to heavier and harder materials. In the aircraft industry, coated aluminum alloys now are being used or considered for gears, pinions, bearing races, gun blast tubes, slides, and helicopter blade edges.

Other new fields also are opened to aluminum by these new finishes. An all-aluminum orthopedic brace, with the Martin coating applied to joints, is a case in point. Corrosive gases or liquids can be resisted too. In the works for such uses are ammunition components, high-speed pumps, and blower impellers of coated aluminum.

A test run by Glenn L. Martin shows how effective these new coatings are. After 50,000 cycles on a Taber Abraser, a Martin hard coating 2 mils thick wore only half as much as case-hardened steel.

The Alumilite coatings, produced from acid electrolytes, are basically aluminum oxide—a very hard substance. These thin coatings are supported by a relatively soft metal. So they can deform or crack. It's not too hard to cut through them with a sharp instrument. But for rubbing abrasion and erosion, they do a good job.

In the discussion period several views were expressed on how to reduce engine wear. One discusser felt that surface films, coatings, and so forth are the only way to combat it—at least until the whole mechanism of wear is more thoroughly understood. Another engineer suggested that emphasis be put on giving wear surfaces a grid pattern similar to that of cast iron. The resulting mass of tiny pits would hold lubricant better—and reduce wear, he stated. If high stress levels will be encountered in a part, however, it's important that the anodic coating be thin and flexible, one questioner was told.

"Nodular Iron in Tractor Motors" by H. L. Day, Automotive Specialties Mfg. Co.

PRODUCING nodular iron is fairly simple, but making parts of the metal can be tricky.

A case in point is the interesting tendency of this metal to form a smooth glossy surface when cast in a shell mold. That's a desirable feature. It produces superior surface chemistry and permits closer casting tolerances.

But the beneficial effects of this skin may be overshadowed by something known as the cope effect. It seems that a film collects on the cope surfaces of nodular iron castings which is thick enough to be an imperfection. Green sand moldings may accentuate the cope effect and bring another foundry plague—the pin hole effect.

Then there's another troublesome item to guard against. That's the occurrence of massive carbides. They hurt both ductility and machinability.

Another serious objection to nodular iron, as made in the past, is the variation in modulus of elasticity of metal made from the same melt. It's undetectable from composition. Microstructure as affected by casting procedure and heat treatment are the controlling factors.

Despite these problems, nodular iron has many desirable properties. It's finding its place as an engineering metal in tractor engine parts. It's beginning to show many promising results.

"Irons with Spheroidal Graphite" by R. W. Mason, Jr., Engineering Castings, Inc.

NATIONAL Farm Machinery Cooperative, Inc. found a number of uses for nodular iron in parts for farm implements.

Its first success was in replacing white iron in bearing spools and inserts. The foundry consistently got hardnesses over 475 BHN and strength levels comparable to the former product.

Spindles for grain drill disc openers caused trouble. This complicated casting was chilled in the wear points. Chill maintenance was a constant trouble source and the chill also brought excessive scrap. The answer was to cast a pipe bushing into the body for a grease fitting. In that way a strong enough part could be made with adequate shock resistance using magnesium-containing iron. Both costs and scrap losses went down considerably.

Experimental plow shares were tested by local farmers and they reported highly favorable results. None was able to break them in service, and none reported wear resistance less than that of any steel share with which they were compared.

Ductile iron doesn't have all the properties of

At a Committee Meeting Someone said that . . .

Cleveland Section arranges at least two—and often three—plant visits as part of its meetings program each Section year. (Cleveland Section Chairman **R. E. Cummings.**)

Edward K. Brown R. E. Cummings

Two annual student scholarship awards are being successfully administered by the Cleveland Section—one at Case and one at Fenn. A Section Scholarship Award Committee—with data and consultation from the colleges—selects at Case a junior or senior in mechanical engineering; for Fenn, a recent high school graduate.

Basis of selection includes scholastic record, character and other similar factors, but when the decision is close, the student deemed to be in the greatest financial need is likely to get the nod. A combined Student Fund and Award Program has been established to pay its own way. Regular Section funds are not used. The Section paid $200 toward the college expenses of each of the two awardees in 1952. (**Edward K. Brown**, SAC chairman for 1952)

Chicago Section regularly begins and ends each year with a social gathering. It begins with a Playday (featuring golf) in the fall and ends with a Ladies' Night in the spring. (Chicago Section Chairman **Robert Wallace.**)

any of the materials it replaced in our equipment. But we felt it has a suitable combination of properties to produce better parts.

"Ductile Iron as an Engineering Material" by B. L. Stott, State Foundry & Machine Co.

DUCTILE iron has taken like a duck to water in a number of cases where wear and abrasion raised hob with parts life.

Take the case of a liner used in a pump raising concrete vertically through a pipe. The ductile iron liner lasted twice as long as a steel liner.

A heading die for 20 mm shells had been made from several tool steels. Several were then made experimentally in ductile iron and a satisfactory hardening method was developed. The result: The tool steel die lasted about 45,000 to 60,000 shells; life of the ductile iron die was 875,000 shells. The cost of the die was halved and die life was increased tenfold.

To these can be added other examples where ductile iron brought long life to a part. For instance:

- Large chains used by a steel company for moving hot billets from furnaces lasted twice as long.
- Large furnace doors for forging shops showed a 43% improvement in service life over gray iron.
- A drag line maker had trouble with a main drive pinion. The pinion kept breaking and both pinion and driven gear tended to pit. A ductile iron pinion is still operating after two years of service and pitting no longer is a problem.

Discussers emphasized that nodular iron is a whole family of materials, possessing a broad range of properties. And this suggestion was made: If engineers expect to take full advantage of the strength, resistance to wear, and weight saving potential of nodular iron, then they should become thoroughly familiar with its various forms and properties.

"Coating Steel by the ALDIP Process" by D. K. Hanink and A. L. Boegehold, Research Laboratories Division, GMC

THE new ALDIP process for coating ferrous parts with aluminum offers an opportunity to replace strategic, expensive materials needed for heat and corrosion resistance. It doesn't have the shortcomings of other aluminum dip methods.

In many applications ALDIP coated steel has replaced stainless without any performance penalty. One such case is a military tank heat exchanger, formerly made of type 321 stainless. ALDIP coated assemblies have performed satisfactorily in service resisting corrosion from exhaust gas condensate. The switch has saved strategic chromium and nickel. Savings accrued also from fabricating SAE 1010 steel instead of stainless.

In another case, ALDIP coated and diffusion heat-treated exhaust pipe adapters are used on trucks. The adapter is installed in the truck exhaust system in front of the muffler, where the temperatures are high and the exhaust gas condensate collects. Diesel engine type manifolds, made of SAE 1010, are replacing those of type 321 stainless. The saving per manifold amounts to 2.4 lb of nickel and 4.5 lb of chromium.

Other aluminum coating methods have been developed, but they all had disadvantages. In one process, the aluminum is applied in a hydrogen atmosphere. That brings handling problems in draining off excess aluminum. In another process, the precoat metal contaminated the molten aluminum bath. The patented ALDIP process has none of the shortcomings.

In reply to requests for further information about the process, Hanink emphasized the importance of standardizing the techniques used. Definite heat-treatments must be specified for definite periods of time, if the part is to be coated uniformly and so it won't be subject to spalling. This standardized technique, he said, ensures that pinholes are not formed. Although these may not be too serious in some applications, for long-time use under corrosive conditions, the coating should be continuous.

If an assemly is complicated, GM tries to introduce it into the solution in such a way as to eliminate air bubbles. If this is impossible, they use vibratory motion or changes in position to get rid of the air.

No trouble has been experienced in coating any of the SAE steels, he said. As far as highly alloyed steels are concerned, type 310 stainless is the highest type that has been coated.

AIR TRANSPORT . . .

. . . operators hear good news on costs of operating turbine craft.

AIRLINE operators heard good news in two sessions sponsored by the Air Transport Activity.

The panel on turbine-powered aircraft offered cheering reports on operating costs of future turbo-

prop and turbojet airlines at the Thursday afternoon session.

At the Thursday morning session, a crash injury researcher pointed out that the modern forward-facing seats the airlines have been using have many good features. And a British maintenance expert told how incentive-pay plans can cut costs of maintenance.

"Differences in the Design and Operation of Military and Commercial Transport Turbine Engines" by R. T. Holland, General Electric Co.

IT is possible to achieve in the original design of a turbojet the characteristics required for combat, military non-combat, and civil operations. Military operations, particularly combat operations, put more emphasis on performance and output and less on durability and economy than commercial operations do. But variations in operational techniques can make one design match the requirements of all three types of operation.

By designing into this one three-purpose turbojet some of the economy the airlines require, designers will save money for the taxpayers footing the bills for military operations. The airlines and their customers will benefit from the spreading of development costs over military as well as commercial engine production.

"Maintenance Considerations in Design" by Marshall W. Galliers, Wright Aeronautical Corp.

REALIZING that good design can do much to keep down turbine engine maintenance costs, engine manufacturers are acting accordingly. Some of the steps designers are taking include:

- Grouping together components which require routine servicing, like fuel control adjustments, oil and fuel strainers, drain and bleed valves, and ignition controls.
- Employing quick-acting drain and bleed valves and quick attach-detach fastenings in connection with fuel pumps, starters, generators, and hydraulic pumps.
- Providing for use of standard bolts, nuts, washers, hoses, and fittings—as well as use of ordinary commercially available tools.
- Including provisions for support in ground handling dollies and shipping cradles.

"Cost Savings by Component Replacement in Line Maintenance" by C. E. Dixon

TURBOJETS are going to cost operators less per horsepower per flight hour than piston engines now do, currently available Air Force statistics indicate. But, for the sake of this economy, operators will

At a Committee Meeting Someone said that . . .

R. K. McConkey

Milwaukee Section begins in February a series of lectures by men of authority in the industry to help indoctrinate new engineers in basic technical phases of automotive engineering by giving them practical down-to-earth material not yet available in the text books. The series is in addition to regular Section meetings; runs every Friday from Feb. 13 through March 6. It is free to SAE members, costs $5 for non-members. Non-members who pay the $5 and later apply for membership may have that sum applied against their initiation fees.

Lecture subjects are: (1) Thermodynamics of Internal Combustion Engines; (2) Combustion Chamber and Cylinder Design; (3) Piston Ring Design; (4) Carburetor Design; (5) Valves and Valve Gear Design; (6) Engine Characteristics and Tests. . . . The lecture room can accommodate 250; firm reservations for 217 were already in on Jan. 12. (Milwaukee Section Chairman **R. K. McConkey.**)

The job of the Membership Grading Committee is to recommend to SAE Council an applicant's eligibility for election or grade transfer and the grade of membership for which he is qualified. The Council does the electing to membership.

The Membership Committee, whose job it is to invite qualified men to apply for membership, can help the Grading Committee in many ways . . . by asking, for instance, these questions before inviting an individual to apply for membership:

1. Is he qualified? Do his qualifications fit the definition for a grade of membership as printed in the qualification form?
2. Is he interested? Will he make a good addition to the Section's and the Society's membership rolls?
3. Is he someone you would be proud to have as a fellow member of the organization?

(**R. J. S. Pigott** at the Membership Committee meeting.)

have to perform considerable line maintenance work in addition to the work usually done at inspections and overhaul.

Line maintenance will (1) extend engine time between overhauls, (2) reduce hauling of out-of-service engines, (3) reduce the number of engines in the overhaul pipe line, and (4) reduce the number of engines needed for spares.

All of these items cut down on total maintenance expense.

"Some Considerations Regarding Fuels for Turbine-Powered Transport" by P. D. Doran, Pratt & Whitney Aircraft

IT'S the engine manufacturer's policy to design engines capable of operating on fuels whose boiling points fall any place within a relatively wide range and for which specifications on other characteristics can be liberal. But turbine engines are much fussier about their fuel than was originally predicted.

In studying turbojet fuels, Pratt & Whitney Aircraft has burned a total of 200,000,000 gal of some 200 different fuels—enough gallonage to run a DC-6 steadily for 100 years. This company has found that the main troubles apparent now are formation of waxes in fuel reaching the engine and formation of graphitic deposits from burned fuel. Fuel technicians are hopeful that they can find out which molecules are responsible for the waxing and then devise a bench test that will determine whether or not the troublesome molecules are present in a particular lot of fuel. The carbon winding up as graphitic deposits could instead, if engines were designed that way, be exhausted as smoke. But the quantity of smoke would be prohibitively large. Engine men feel they must leave the carbon problem up to the oil suppliers.

Chiefly because of relatively tight quality restrictions, fuel costs for turbojet aircraft will probably be about one-third greater than they are for piston engine aircraft. In view of turbojet fuel costs, airline operators certainly should employ fuel technicians and back them up with adequate laboratory facilities. The fuels staff could keep in touch with both fuel suppliers and engine manufacturers on mutual problems and continually monitor fuel specifications to avoid calling for unnecessary requirements.

Discussion brought out that fuel emissivity factor is another characteristic that will have to be carefully controlled. Kerosene-type fuels vary by as much as 8 to 1 in the emissivity factor their flames exhibit in an engine having an 11 to 1 compression pressure ratio. Temperatures of burner parts absorbing the emitted heat vary accordingly.

Engines will have to be designed and operated on fuels whose emissivity falls within a relatively narrow range. Otherwise burner parts would overheat from some flames and burn out—or run at lower than design temperature, with resulting weight penalty, with flames from other fuels.

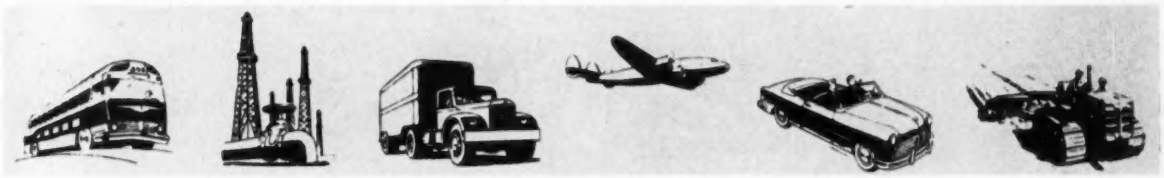
All of 22 sessions ran smoothly thanks to these **session chairmen:**

H. O. Mathews, Armour and Co.
C. F. Kramer, Ford Motor Co.
Robert Gardner, Lever Brothers, Inc.
H. C. Smith, Great Lakes Steel Corp.
F. W. Kateley, ACF-Brill Motors Co.
P. S. Lane, Muskegon Piston Ring Co.
N. R. Brownyer, Timken-Detroit Axle Co.
J. W. Greig, Woodall Industries, Inc.
C. A. Hubert, International Harvester Co.
L. I. Woolson, DeSoto Division, Chrysler Corp.
E. N. Cole, Chevrolet Motor Division, GMC
F. N. Piasecki, Piasecki Helicopter Corp.
J. B. Macauley, Jr., Ethyl Corp.
F. E. Carroll, Jr., United Aircraft Products, Inc.
W. G. Ainsley, Sinclair Research Laboratories, Inc.
O. E. Kirchner, American Airlines, Inc.
J. W. Pennington, Koppers Co.
A. W. Dallas, Air Transport Association of America
Malcolm Ferguson, Bendix Aviation Corp.
J. G. Moxey, Jr., Sun Oil Co.
J. B. Johnson, Wright Air Development Center
F. A. Suess, Continental Oil Co.

"Effect on Direct Operating Cost of Frontal Area, Specific Fuel Consumption, and Engine Weights" by J. E. Steiner, Boeing Airplane Co.

FOR turbine engines, the drag associated with engine frontal area is not so important to operating cost as the engine inlet or outlet condition. The drag due to the engine runs about 14% with turboprops and about 11% with turbojets; with reciprocating engines, it's about 19%. A 5% reduction in turbine engine drag saves only about 1% in operating cost.

Cost considerations rule out light-weight turbine engines with high specific fuel consumptions



for commercial airline operations, especially for long flights.

During the discussion period Steiner emphasized that the growth factor (pounds increase in total airplane weight per pound of equipment added) will be higher for turbine-powered transports than the 2/1 ratio quoted for the DC-6. That means, he said, that the penalties of adding weight over the design figures will be especially severe. He advised airlines to see that the weight of engines and other equipment be estimated realistically for airframe design.

"Protective Design in Forward and Rearward Facing Seats in Transport Aircraft" by Hugh DeHaven, Crash Injury Research, Cornell University Medical College

THERE'S more to the seat safety problem than just the direction in which the seat faces.

True, a person facing aft is less likely to crack his skull in a straight head-on crash. But if the airplane cartwheels or tumbles, he may break his back or sustain other serious injuries if he falls part way out of his seat and is then thrown against an armrest or the edge of the seat back.

We won't have the complete answer to the forward-versus-rear facing seat question until we know more about the forces involved in crashes. The data we have indicate that average crash forces may be quite low. If that's right, forward-facing seats may be as good as any.

Airline operators, we believe, may ultimately go to rearward-facing seats for their extra safety in crashes where the forces are high—and because the passenger gets a better view.

Discussers confirmed DeHaven's suggestion that there are often high side loads in crashes, which throw passengers hard against armrests.

Strong seat belts don't cut people in two, he emphasized. Experience has shown that a 100-lb person thrown at an extreme peak force against a belt tested for 2000 lb in tension can break it without injuring himself, DeHaven added.

"The Economic Aspects of Incentive Systems for the Maintenance and Overhaul of Aircraft" by Hugh Gordon, British European Airways

BEA is paying its maintenance mechanics on an incentive system and saving money by doing it.

Time and motion study engineers set a standard time for each maintenance and overhaul operation. If the mechanic does the job in less than the standard time, he is paid his hourly rate for the standard time plus his hourly rate for half the time saved. Thus the mechanic gets more in his pay envelope and the company saves.

Application of this incentive scheme enables BEA to accomplish its maintenance with 250 fewer men than the 1125 employed at the time the plan went into effect.

In answer to questioners, Gordon said that the plan has encouraged the men to use their brains as well as their time. They have developed a number of time-saving special tools. BEA usually buys the idea from the mechanic and retimes the job instead of continuing to pay at the premium rate, Gordon explained.

Non-productive employees, like clerks and sweepers, are not included in the incentive plan but seem satisfied with their lot, he reported.

He emphasized the importance of getting labor and

More on Page 80N

The men who carried the responsibility for recording discussion of papers presented at the meeting were these **session secretaries:**

Henry Jennings, "Fleet Owner"
R. A. Terry, Creative Industries of Detroit
Walter Mincho, Great Lakes Steel Corp.
W. J. Locke, Timken-Detroit Axle Co.
E. B. Etchells, Chevrolet Motor Division, GMC
W. S. Rigby, Wagner Electric Corp.
Robert Anderson, Chrysler Corp.
L. S. Pfost, Massey-Harris Co.
C. J. Van Halteren, DeSoto Division, Chrysler Corp.
W. R. Mackenzie, Chevrolet Motor Division, GMC
R. S. Knecht, Bureau of Aeronautics
H. A. Toulmin, Ethyl Corp.
R. I. Cross, United Aircraft Products, Inc.
H. D. Young, Sinclair Research Laboratories, Inc.
P. M. Bishop, American Airlines, Inc.
L. D. Thompson, Fairbanks, Morse and Co.
Whitney Collins, Continental Aviation and Engineering Corp.
H. A. Gossner, Bendix Aviation Corp.
F. C. Burk, Atlantic Refining Co.
J. R. Long, National Research Council
J. E. Kline, Standard Oil Co. (Indiana)

Main ideas brought out in discussion will appear together with abridgments of the papers in later issues of SAE Journal. Papers approved by Readers Committees will be printed in full with discussion in SAE Transactions.

These papers are also available in full in multilithographed form from SAE Special Publications Department at 25¢ a copy to members and 50¢ a copy to nonmembers.

Admiral Ben Moreell (center), chief speaker at the Annual Meeting Dinner said that "Our sole hope for continued progress in social consciousness and behavior lies in improvement by the individual of his own moral stature." Detroit Section Chairman P. H. Pretz (left) opened the dinner program with a welcome to the members and guests. A. T. Colwell (right), master of ceremonies, introduced the speakers and stressed that "Our American standard of living is the result of productivity in an atmosphere of freedom and has been achieved through the use of tools, methods, and man-effort."

Dinner

Colwell

Moreell Urges Reformers To Reform Themselves First

IMPROVEMENT by the individual of his own moral stature is our sole hope for improved social consciousness, Admiral Ben Moreell, Chairman of the Board, Jones & Laughlin Steel Corp., emphasized in his address to the 1953 SAE Annual Dinner. He saw no hope for progress in the ever-increasing power of what he dubbed "social engineers" to regulate and control our lives, our morals, and our properties. The best place for a reformer to start reforming is on himself, Moreell said.

Social engineers, according to the Moreell definition, are people dedicated to the thesis that, by using government force, mankind can be changed and molded to conform to a master plan in much the same way that engineering materials can be processed in accordance with preconceived plans. Moreell says it can't be done.

Scientific engineers, among whom he included SAE men, can predict the behavior of the materials and forces of nature, he said. This is in contrast to the "social engineer" who "either knows nothing of nature's immutable laws or chooses to ignore them. Instead," he went on, "they have their man-made and variable laws of compulsions, prohibitions, and other restrictions on the free actions of individuals by which, they claim, man's behavior can be compelled in a way that will redound to the good of mankind."

Granting everyone the right to plan, Moreell decried the right of the social engineers to *force* anyone to *conform* to *their* plans. He said:

"We scientific engineers do not need laws to force people to adopt our plans or to buy our products. Each of us is willing to leave the decision to the

Hears Moreell; Is Toastmaster

competitive market where all persons have complete freedom to buy or not to buy, to join or not to join, to invest or not to invest.

"But these would-be managers-at-large of society are not willing to extend freedom of choice to others than themselves. They must have the power of government—the police force—behind their plans and products or they are helpless. They are well aware that in almost all cases a free people in a free market would reject their wares. That is why they want to abolish the market economy and force people to conform to their plans or to suffer the penalty of fines and imprisonment."

Admitting that "good intentions", sincerity, and desire to do "good for the people" motivate many of the social engineers, Moreell pointed out that they inevitably end with the use of force and violence and are devotees from the start of the pagan concept of authority.

He concluded that "equality", the slogan of the social engineer, can only be achieved in terms of equality before the law. Equality of possessions, equality of intelligence, equality of security cannot be attained.

Recognizing that there have been grave misuses of human and natural resources in the Western World and decrying them, Moreell pointed out that there has been a steady, substantial and voluntary improvement in our social consciousness and behavior.

Before the Dinner. . . .

1953 SAE President Robert Cass (left) and 1952 SAE President D. P. Barnard (right) compared notes prior to the Annual Meeting Dinner at which both were speakers.

BARNARD said that "SAE has the unique responsibility of facilitating cooperation and the exchange of mutual aid between technical men engaged in research, development, and selling of the keenest competitive type." He emphasized that "there are many problems of broad mutual interest necessary to the successful development of the industry and also required in the best interest of the customer."

CASS said that automotive engineers still face great and challenging frontiers, even though our generation has outstripped its ancestors in tools and tons. Mentioning substitutes for critical materials as a sample of these challenging frontiers, he pointed out that:

"Whatever substitutes are found will be called upon to do even more work, handle more heat, and live as long or longer than the materials for which they have been substituted. The progress which has been made in the SAE in its nearly 50 years of life," he concluded, "shows very clearly the degree to which we will be called upon to go more quickly and more surely along future lines of sound development."

management to sign a detailed piecework agreement giving management the right to retime jobs when the original standard proves incorrect and when the operation changes.

SYNTHETICS . . .

. . . for lubricating turbines are expected to do much more than just lubricate.

THE dream of lubrication engineers and chemists—according to the experts at the question-and-answer forum on Synthetic Lubricants for Aircraft Gas Turbines—is to synthesize a lubricant that will pump readily at temperatures down to - 65 F, operate satisfactorily at temperatures as high as 700 F, carry the loads imposed by turboprop gears, lubricate high-speed anti-friction bearings, act as a hydraulic fluid for certain engine controls, refrain from attacking the elastomers in seals and hoses, prevent rust, leave no deposits, and absorb no water.

To achieve this ideal lubricant, they are experimenting principally with five types of synthetics:

1. Diesters—These appear at least to some investigators to be the most promising. The basic building blocks are available from many sources.

2. Polyglycol ethers—Characteristics of this group of synthetics are similar to those of mineral oil lubricants, but the ethers have more favorable viscosity-volatility characteristics and low-temperature properties.

3. Silicones and silicates—These synthetics show lubricity deficiencies.

4. Phosphates—Viscosity and low-temperature properties of these compounds are good, but they are hard on elastomers and metals.

5. Hydrogenated lubricants—Non-flammability of these lubricants is outweighed by their inferior viscosity-volatility characteristics and instability.

Synthetic lubricants now being used cost around $9 per gal, but consumption is so low in the closed systems of advanced turbines that even this price causes little immediate concern. Cost is expected to come down as production goes up and as more economical base stocks are developed.

The military services are procuring synthetic lubricants to MIL-L-7808A (USAF), which is the November 1952 revision. It specifies a coking test, in which spinners spray oil up on hot plates and the gain in weight of the plates after 8 hr is the measure of coking. Also required is a four-square gear test.

More such lubricant performance tests are needed to aid in development of better synthetic lubricants, panel members and discussers from the audience agreed.

Frank Carroll, Jr. of United Aircraft Products served as chairman of the panel on Synthetic Lubricants

Members of the panel were H. A. Murray of The Texas Co., E. F. H. Pennekamp, of Esso Laboratories, E. L. Margolin of the Wright Air Development Center, M. C. Hardin of Allison, R. W. Blair of Wright Aeronautical, and Stephen Drabek of General Electric's Aircraft Gas Turbine Division

Cost Conscious . . .

. . . truck engineers debate how long to repair and who should do work.

LET the dollar decide—and make sure the decision is based on up-to-date cost figures, fleet operators and truck manufacturers emphasized in two Transportation and Maintenance Activity sessions and one Body Activity session, all on the first day of the meeting.

Recent trends in costs make it economic to replace vehicles earlier and do less overhauling, one fleet manager asserted. He stressed the combined effects of fleet discounts and high resale values in addition to the relatively high cost of mechanics' labor.

No matter how fast fleet operators replace vehicles, there's always some maintenance to be done. No agreement was reached on whether it's cheaper for the operator to do it in his own shop or have it done in a dealer shop. But it was generally agreed that the answer depends partly on fleet size. Small or scattered fleets are usually better off relying on dealer shops, where good dealer shops exist. Large or remotely located fleets can justify the investment involved in shops of their own.

It's important that there be good two-way communication between manufacturer and maintenance personnel. Factory service experts have much to show shop men—and shop men and drivers can give manufacturers valuable tips on improvements. Designers are definitely and vitally concerned with designing trucks that cost less and carry more, a spokesman said.

"Fast Replacement or Heavy Maintenance"

by C. C. Hudson, Tennessee Valley Authority

IT'S often cheaper for a fleet operator to replace a vehicle or a component than to overhaul it.

The way to determine whether to get rid of used units and buy new or to repair the old ones extensively is to analyze the economics of these two alternatives. And this analysis should be made frequently because as relative costs of labor and parts change, the optimum replacement point changes.

Fast replacement—that is, replacement before overhaul time—proves economic particularly for fleet vehicles of the high-volume, mass-produced light types, some operators have found. Fleet sedans can often be replaced at one year or 20,000 miles with substantial overall savings.

Where it's not economical to replace the whole vehicle, it often pays to replace certain components rather than to overhaul them. Perhaps it would be more economic still to have them overhauled in manufacturer's unit rebuilding shops—if there were such shops located around the country.

Discussers agreed that generally it is economical to replace light, cheap, mass-produced vehicles before they need extensive overhaul—and conversely that it is worth while to overhaul heavy equipment and special-purpose equipment, whose resale value is a relatively smaller proportion of new-vehicle price.

Operators were warned, however, not to put all their replacement money into the light, mass-produced vehicles every year. Sometimes the money will bring greater returns if invested in a new special-purpose vehicle of greater productivity than the older special-purpose unit it replaces, even if the old unit has low resale value.

"Some Factors Concerning Bodies and Related Components for Commercial Vehicles"

by E. P. Lamb, Chrysler Corp.

TRUCK engineers are well aware of the need for minimizing operators' costs and eager to help. Some of the things they are doing for operators to keep costs down are:

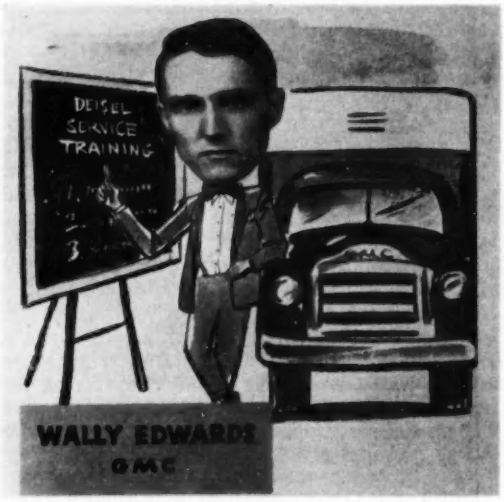
- Designers of one line of trucks standardized on grilles and certain sheet metal panels and used them throughout the line. Applying standardized parts throughout all 84 different 1951 models lowered production costs on every one of them.
- Body engineers plan stampings so that they can be nested for storage and handled without damage. Fewer truck parts are needed than passenger car parts, but that fact does not permit a lower production rate of truck items. Production equipment must be kept busy to pay its way. So it is run full tilt on truck parts, then switched for a part of the year to other low-volume items. The nested semi-finished parts are stored for use as needed. The truck consumer benefits from the increased utility of the production equipment.
- Designers are investigating power steering with the idea that it would enable them to boost front axle loading close to the legal limit without unduly burdening the driver.

Asked by one discusser what's being done to combat corrosion of sheet metal, Lamb stated that the main approach is to use Bonderite prior to painting. Reduction of joints, plus better sealing and drainage of doors, are other precautions taken.

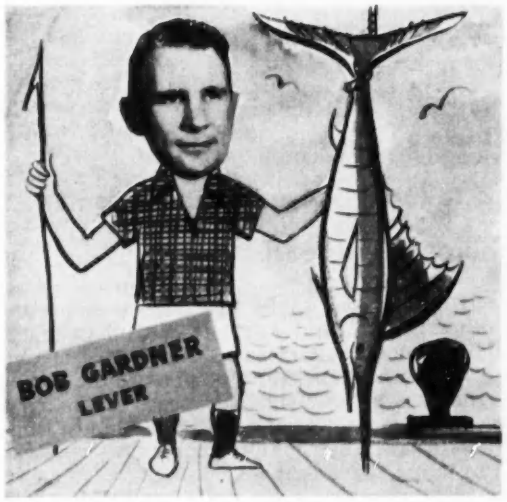
Another member of the audience wondered whether the higher cost of aluminum alloys is offset by return from increased payload. He was told that trucks in more or less constant use, such as those on the West Coast, are better able to take advantage of lighter construction. Production costs on high-volume, low-cost trucks however, make use of aluminum alloys hard to justify.

Symposium—An Engineering Approach to Service Problems

These are the cartoons Symposium Chairman Bob Gardner flashed on the screen



to introduce his panel speakers



"Why Use Dealer Shops to Service Fleet Vehicles?" by Carl T. Doman, Ford Motor Co.

ONE argument favoring the dealer shops is that whoever performs the maintenance has to make a considerable investment in land, buildings, equipment, and inventory. Small fleets—which own the great majority of U. S. trucks—usually don't get enough use out of special equipment and inventory parts to justify the investment. They are better off letting the dealer make the investment and realize his profit on it from a number of customers.

An even bigger argument for the dealer repair shop is its close relationship with the factory.

"How Factory Training and Service Publications Provide Advantages in Use of Factory Branches and Dealer Shops" by W. W. Edwards, GMC Truck & Coach Division

THE well-run dealer shop takes the time to keep up with the manuals, parts books, special service letters, and other technical literature that factory service organizations put out. It also sends men to the training courses and service conferences the factory service organization sponsors.

These aids are available also to fleet shops. But fleet shops seldom can spare the men and the time to take full advantage of the service aids. This is true especially of shops working on several makes of vehicles.

The dealer shop's familiarity with service literature is a good reason for fleets to purchase maintenance instead of setting up their own shops.

"Advantages for a Fleet in Purchasing Guaranteed Maintenance" by F. G. Allen, White Motor Co. Presented by F. L. Snyder, White Motor Co.

WE are maintaining several thousand trucks for customers under three kinds of contracts:

1. Preventive maintenance contracts establishing a cost per month or mile for the greasing, minor repairs, and washing on a particular truck.

2. Guaranteed maintenance contracts specifying that we assume responsibility for repairs and labor under given operating conditions at a stated price per mile over a period ranging from 50,000 to 100,000 miles per year, over a period of three years for a particular truck.

3. Guaranteed maintenance contracts covering

materials as well as labor, under the conditions mentioned for the second plan.

We have data for calculating prices on these plans for any of our trucks, used as well as new.

"Preventive Maintenance, Repairs, and Cost Controls for a Scattered Fleet" by Walter H. Langseder, Thomas J. Lipton, Inc.

SCATTERED fleets with no sizeable concentration of vehicles in any given area are practically forced to rely on dealer shops. The operator of the scattered fleet should select the dealer shop with the same care he would exercise in hiring men for his own operation. Unfortunately it isn't always easy to find good dealer shops.

Even though he uses dealer shops, the fleet owner has these three management duties regarding maintenance:

1. He should have a fleet superintendent with responsibility for economic maintenance of the vehicles and the authority to achieve it. It should be the duty of the superintendent—or his deputy—to cooperate with the dealer shop by giving notice well in advance of work going in, assist in the diagnosis, and if possible write the repair orders.
2. Drivers must be trained to operate properly and to recognize danger signs.
3. Company policy ought to include a preventive maintenance program tailored to the fleet and an equipment retirement plan—both of which should be re-examined frequently in the light of current economic conditions.

"What Are the Advantages of A Fleet's Operating Its Own Shops and Having Traveling Inspectors?" by Robert W. Thomas, Quality Bakers of America Cooperative

WE find it better to operate our own shops than to use dealer shops. Here's why:

We have three types of operation: (1) fleets of 50 to 100 or more trucks headquartering in large cities; (2) fleets of 20 to 50 trucks operating out of cities of 50,000 to 100,000 population; (3) scattered groups of 1 or 2 trucks located at very small towns.

Bakeries operating the fleets of 50 or more trucks can provide in their own shops better service with less confusion at lower cost than dealers offer, we find.

Few cities in the 50,000-100,000 class have dealerships competent to provide the needed service, at any price. To service their 20-50 vehicle fleets, our bakeries employ a working foreman and a mechanic or two, plus a man for greasing, washing, and gassing.

To service the scattered units, we have outfitted a stripped house trailer with a bunk and shower for a traveling mechanic and a work bench with vise, a light grinder, tool racks, and cabinets for spare parts. Also carried are a jack, stands, a wheel balancer, and an air compressor.

The trailer is pulled by a spare route truck. When the mechanic arrives at the local distribution point, he disattaches the trailer, gives his truck to the salesman, and works on the local truck.

"From Truck Driver to Truck Design Engineer" by Frederick K. Glynn, American Telephone & Telegraph Co.

FLEET owners, let's open up the communication line from the driver back to the truck engineer. First step is to give the driver a trouble report that he makes out at the end of his run, whether or not there is trouble. Attached to the driver's report, let's have a mechanic's report form, part of which goes back to the driver and part lists time and parts used and goes to the accounting department.

If one item on a particular model fails again and again, compile data relating to it from the driver's trouble reports. Add to your compilation ideas of mechanics, garage foremen, and inspectors. Then present your documented complaint to the factory service representative.

Usually his organization will come up with a solution promptly. If it doesn't, hammer away until you get one.

CARS . . .

. . . are tailored to meet public demand, both here and abroad.

TAILORING the coat to fit the man is a pretty sound maxim . . . and so it is with passenger cars. That's what audiences at Body, Passenger-Car, and Fuels and Lubricants sessions found out.

Take the case of post-war European cars. Here economics and geographical conditions dictate that cars be small—and their manufacturers are realistic enough to make them that way.

Stock car economy runs, on the other hand, stimulate public interest and demand for better economy. And here again engineering know-how is being massed to meet this demand.

What's more, a retailoring project may soon be

put in the hands of body designers, too—if predictions made for glass-reinforced plastics come true.

"European Post-War Cars" by Maurice Olley, Chevrolet Motor Division, General Motors Corp.

EUROPEAN post-war cars are the product of a lot of realistic thinking. European manufacturers recognize that:

- Dollars for buying and operating cars are scarce.
- Widened and expanded highways just aren't in the picture—farm land in many countries is far too vital to use this way.
- Cities can't be rebuilt to relieve traffic congestion.

Economics and practicality, they realize, dictate one thing—small, inexpensive cars that can operate on narrow roads on a minimum of precious motor fuel. In short, the European problem is to combine a large interior with a small exterior.

Baggage space, therefore, is low. Overhangs in both front and rear are less than in American cars. Bumpers are less massive. Interior widths are based on two passengers, not three. Interior height is lower.

Expediency—and originality—are exhibited in other ways too. To get around the tendency of 60% of car weight to fall on the front tires, some builders use front-wheel drive or put the engine in the rear. Many cars are equipped with swing axles to help them hold the road better. Two-cycle engines, which contain a minimum of parts, are used to keep down service and because they appear to be immune to cylinder wear.

While it's true that European manufacturers have to keep their imaginations under restraint as regards mere size, they are vigorously exploring ways to improve their product.

Europeans stick to smaller cars for two main reasons, says W. D. Appel, Ford Motor. They are after:

1. Lower operating and maintenance costs, and
2. Lower first cost.

The only way to reduce operating costs is to make light cars with lower performance standards. This inevitably leads to a smaller car.

And you reduce the price of the car by having fewer and simpler parts. Here again size reduction of parts helps.

Appel also has an explanation for the wide variety of technical design in European cars. He says basically the European engineer is an entrepeneur and an individualist. He wants to create a vehicle distinctly different from his competitor's. There's also extreme competition and low volume. This allows the ingenious European engineer to develop and try out new designs.

American manufacturers would shrink away from such

From an

Eavesdropper's Notebook. . . .

Orville Brouer

SAE Vice-President **Orville Brouer**, approaching grandfatherhood for the third time, was told this by **"K" Glynn**: "The discouraging part of being a grandfather is being married to a grandmother."

Definition: A Texas longhorn story, says Detroit Section Chairman **Phil Pretz**, is two points separated by a long distance, with lots of bull in between.

Quotes from A. T. Colwell: "A lack of the atmosphere of freedom will be the weakest link in Russian aggression if it ever comes."

* * * *

"In the last few years our automobile engineers have taught automobile transmissions a great principle—namely, how to shift for themselves. . . . Let's hope that this same principle will actuate certain of our politicians who seem to have forgotten it during the last 20 years."

"K" Glynn solved the old problem of making best use of the space on a lantern slide. The slide of a driver report form he was proposing appeared tipped on its side but read "THIS SLIDE IS RIGHT SIDE UP. JUST TILT YOUR HEAD TO THE LEFT." Next slide was lettered, "THIS TIME TILT YOUR HEAD TO THE RIGHT . . . IF YOU WANT TO READ THE FINE PRINT, SPEND TWO BITS FOR THE PREPRINT." Sales boomed, we understand.

From an

Eavesdropper's Notebook. . . .

Maurice Olley

Of some European small cars, **Maurice Olley** says: "You don't so much get into them as put them on!"

Lee Oldfield came up all the way from Mexico for the meeting. He is living there in retirement in a trailer—but says he just can't keep away from his old friends in SAE.

The audience at one session learned about an entirely new factor in detonation and autoignition of passenger-car engines—women. It seems that a certain engineer got wonderful results with his high-performance car until his wife took over the driving. After the 90 days that she had acted as his chauffeur, the engine was detonating on premium fuel and suffering from autoignition!

Neil Petersen

Where words win out over wheels: Many Danes would rather invest their money in a library and curl up with a good book, than buy a car. That's one of the observations reported by SAE Production Vice-President **Neil Petersen**, who visited Europe last fall. And eating in Denmark must be a national pasttime too, judging by the frequency with which the Dane takes a break for a light snack each day.

new features until time has proved their value and the public has accepted them.

Ethyl Corp. tested one European car, the 1952 Jaguar XK 120, and found it has some interesting performance characteristics, reported Harry Toulmin, of Ethyl.

The "Jag" is about 300 lb lighter than a standard Chevrolet and has an engine of 6 cu in. less displacement.

The car is extremely stable, can negotiate highway turns at 80 to 100 mph with practically no roll or sway. It's possible to accelerate smoothly in top gear from 10 mph to the car's top speed of 120 mph.

The car has excellent brakes, so that high roads speeds are possible with safety, said Toulmin. But by U. S. standards, the engine and gear box are quite noisy and the ride harsh.

"Will Glass-Reinforced Plastics Replace Metal in Automobile Construction? If So, When and Where?" by Games Slayter, Owens-Corning Fiberglas Corp.

JUST as steel replaced wood, so will glass-reinforced plastics replace metal in automobile construction. Already Fiberglas itself appears in most cars as a thermal or acoustical insulator. But impregnate it with plastic and its potential uses multiply tremendously. It then becomes a suitable material for such parts as fenders, body panels, bumpers, wheels, structural members, trim, molding, springs, gears, and so forth.

That's because the stuff is strong, light, shock-resistant, non-corrosive, self-damping, attractive, needs no paint, and is easy to press and mold. What's more, it resists cold and heat transmission and is easy to repair. Damage, which appears as a puncture or a crack, can be rapidly repaired with only heat and patching. It doesn't have to be bumped out with dies, shapes, and hammers.

One question that will have to be solved, however, is the form in which the material will be supplied to fabricators. It's important that it be in a physical condition suited to existing manufacturing methods.

"The Cement of Reinforced Plastics for the Automotive Industry" by E. S. Ebers, Naugatuck Chemical Division of United States Rubber Co.

MUCH has been said about the methods of construction and potentialities of glass fiber reinforced plastics in automobiles . . . but the really important thing is how a "plastic" car will stand up in service. Over 28,000 miles of operation of a test model throughout the U. S. provide the answer.

The glass fiber reinforced polyester body of this automobile had sufficient strength to survive minor accidents without major repair costs. At no time did it rust or lose its paint. It operated satisfac-

torily at temperatures greater than 140 F and less than 10 F. What's more, not only did it exhibit good dimensional stability under both wet and dry conditions, but its fatigue resistance was such that it was able to absorb normal body torque.

In a discussion period following presentation of their papers, Slayter and Ebers were assisted in answering questions by I. M. Scott, Winner Manufacturing; Harold Freeman, American Cyanamide; Roger White, Glastic Corp.; Harold A. Hoppenns, Plaskon Division of Libby-Owens-Ford; W. E. Wirsch, Rohm and Haas; and Arthur Wiltshire, Apex Electrical Manufacturing.

Slayter told a questioner that Fiberglas has turned out reinforced dichlorostyrene parts experimentally at the rate of four parts per minute. Dichlorostyrene for commercial use is, however, at least two years away, he reported.

Glass for reinforcing plastics is cheap, resistant to temperatures up to 700 F, and need not present skin-irritation problems, the experts brought out. Both glass and resin withstand aging well, they added.

"The Economy Run—Par for Gasoline Mileage" by W. S. Mount, Socony-Vacuum Oil Co., Inc.

STOCK car economy runs, by stimulating public interest and demand for better economy, are opening up opportunities for engineers to apply their economy know-how.

They have shown what can be done with modifications of rear axle gear ratio. They were a factor in the development of dual-range automatic transmissions. They popularized overdrive. Their altitude effects have focused additional design attention upon the newer, more complicated carburetors. And they have emphasized well-balanced gasoline, especially volatility.

The 1952 run left the distinct impression that reasonably high power is a factor in economy if kept in reserve until needed. Automobile manufacturers are meeting this demand for more power with designs up to 200 hp and higher.

Future runs will undoubtedly emphasize proper use of power for driving with less effort, efficient hill climbing, and all around flexibility. Waste of power or conversion to dangerous speed will be discouraged.

Discussers had a few ideas of their own as to what economy runs might accomplish—both directly and indirectly. One proposed that part of the course might be used to dramatize the effect of poor highway layout on economy.

Another suggested that, just as economy run drivers often log the course to improve economy, so the driving public would do well to map out its journey in advance to avoid hills and congested areas.

From an

Eavesdropper's Notebook. . . .

When asked how long a helicopter rotor blade normally lasts, **Frank Piasecki** replied: "Until it gets hit by a hangar door."

Past-President **A. T. Colwell** at dinner of Past-President's Advisory Committee told the following as Lion Story Number 4:

A London explorer advertised in the daily paper for someone to accompany him to Africa on a lion hunt. About 3 a.m. on the night following the advertisement's insertion, he was awakened by a ringing of his doorbell, knocking on his door, and loud but incoherent calls for attention at his front door. He crawled from bed, donned his dressing gown and made his way to open the door. There he was confronted by an obviously well-oiled playboy who stood swaying on his doorstep.

"What do you want?" he demanded brusquely.

"You the fellow that advertised for someone to go to Africa with you to hunt lions?"

"Yes, I am. What of it?"

"Well, I shust want tell y'u, that under no circumstances whatever can I go yith y'u."

At the Thursday afternoon Air Transport session, **Jack Steiner** of Boeing offered a new definition of engineers—"People who think otherwise."

Section Committee Chairman **Robert Insley**, describing an unsatisfactory financial statement: "It gave a breakdown of expenses understandable only to a man who has had three sons in college at the same time."

Robert Insley

TESTING . . .

. . new tests, new test equipment, new test techniques aid auto progress.

THE design, development, and manufacture of automotive vehicles—and the parts that go to make up these vehicles—involve the performance of many tests, starting with the very materials out of which the parts are made, and continuing until the performance of the complete vehicle is measured.

Thus, some of the papers at this meeting—as at most general meetings of the Society—brought engineers up-to-date information on new tests, new test equipment, and new test techniques for use with already known tests.

The new tests described included one for determining the drawability of sheet steel, a low-temperature sludging test, a method of identifying preignition, a method of measuring the rate of fuel injection in an operating engine.

Some of the equipment used in the new Alden Indoor Proving Ground, which was built to test driving axles, was described.

Another paper was written to provide guidance for those contemplating making engine-cylinder measurements for the first time.

Finally, data were presented that should prove helpful to those contemplating using the SAE Standard Test Code for Brake Dynamometers—which will appear in the 1953 SAE Handbook.

"A New Test for Drawability of Sheet Steel" by C. B. Buker and J. R. Speer, Jones & Laughlin Steel Corp.

A TEST procedure has now been developed that is proving most helpful in determining the forming characteristics of cold-reduced sheet steel. Two portable instruments are used in performing the test.

1. Flex-Tester. With this instrument one corner of a sheet of the material being tested is bent through a given arc. The resistance of the material to the bending force causes a tongue portion, acting as a cantilever spring, to deflect. This deflection is recorded on a dial gage in what are arbitrarily termed *F* units.

2. Spherometer. This instrument has been specially designed to measure maximum curvature of the flexed corner. The highest dial unit obtained is the deflection of the material in 0.001 in. across the span of the two outside instrument points. The dial units have been arbitrarily termed *R* values.

This test procedure is claimed to have many advantages. Among them are:

No specimen preparation is required, so the test can be applied to the raw material. It is simple, convenient, and nondestructive. *R* values can provide the mills and stamping plants with the first production test to determine stretcher-strain characteristics.

Flex values can indicate most suitable stock for direction to a given application. This is particularly advantageous where stock sizes are used for more than one part.

Estimates of quality can be made at receiving time at a stamping plant. A consideration of aging changes then permits the immediate use of borderline material and storing of better material for later use.

Flex values can be used to show the changes in rate and degree of aging in strip steels. For example, materials with low flex values a few weeks after mill tempering are probably of the nonaging type.

R tests can show whether a cold-reduced material can be applied directly to smooth surface parts or whether a roller level pass is required prior to stamping. The jump-roll of the sheet processor should be used only when *R* values indicate it to be necessary.

The test is said to have a very promising future in both strip mills and stamping plants. It should provide a tool for research investigation as well as a welcome addition to control methods.

Main interest of the discussers of this paper was in the application of the test to other materials.

Ed Hahn, Lanner Corp., wanted to know if it could be applied to stainless steel. Mr. Buker said that limited tests to date indicated that it probably could. In fact, he continued, it should be applicable to many materials, so long as the yield point is fairly low. If the yield point is too high, he said, the material simply springs back, so that a reading can't be obtained with the instrument.

Another questioner asked if the test could be applied to very thin materials, such as tinplate. Mr. Buker said that they had had satisfactory results with aluminum 0.019 in. thick.

The testing of tin plate will require some changes in the instrument, he pointed out. Such an instrument is now being developed, he reported, because of the many requests for one.

"How a Proving Ground Was Moved Indoors" by Lawrence W. Fischer and Roy W. Roush, Timken-Detroit Axle Co.; and Earl B. Stavely, Jr., General Electric Co.

THE Alden Indoor Proving Ground is a complete installation for testing driving axles. It is capable of duplicating the actual service of any vehicle

traveling over any route.

With the instrumentation that has been added to the new dynamometer equipment, measurements can now be made of any internal deflections or movement that may occur in the vital internal parts of a driving axle under all conditions of load, speed, and in both directions of rotation.

All of these mechanical movements are registered electrically by means of differential variable transformers and are indicated by the light pattern of the calibrated screen of a cathode-ray oscilloscope.

The maximum conditions that can be simulated by the equipment are:

1. An engine producing 710 ft-lb of torque at 1600 rpm and having an inertia of 48 lb-ft^2.
2. Transmission ratios varying from 1/1 to 6.5/1.
3. Rear-axle ratios varying from 4.5/1 to 9.23/1.
4. A vehicle weighing 80,000 lb, operating at 60 mph.
5. Rear-wheel diameter of 46 in.

The most novel feature of the unit is the automatic cycling equipment. This system provides a means of reproducing in the laboratory the torques and speeds actually encountered on the road, with the ability to repeat these tests accurately time after time. Moreover, shock loading tests can be run that heretofore had seemed impractical.

Discussion—Via Television

Axle differential speeds can be recorded on the tape, Stavely told Joel Maxey, of Ford. However, to do so would take one more oscillator and another channel on the tape recorder.

Howard Felder, of Clark Equipment, inquired about the anchoring of the differential variable transformers used to measure deflections. He wondered how it's possible to get a point of reference, "for axles, like many other things, are all rubber and all moving." According to Roush, the transformers are anchored to a very rigid steel bar, which is attached to the axle housing. It extends around to convenient places where the transformers are attached.

Roush also told Muir Frey, of Allis-Chalmers, that it's possible to simulate brake tests with Timken's new dyna mometer equipment. The axle on test is equipped with brakes and brake drums. The brakes can be operated as part of the regular testing.

Clutching and gear shifting also can be simulated, Frank Kateley, of ACF-Brill, was told. It's done manually by adjusting speed and torque. First speed is increased rapidly to a certain point, then backed away; the dynamometer is allowed to coast for a few seconds. Then it is accelerated to a higher speed, backed away, and allowed to coast again. This procedure can be continued for as many shifts as you have to make, said Roush. And all of this can be recorded on the tape.

Merrill Horine, of Mack Mfg., noted that the television demonstration showed the test equipment operating at a

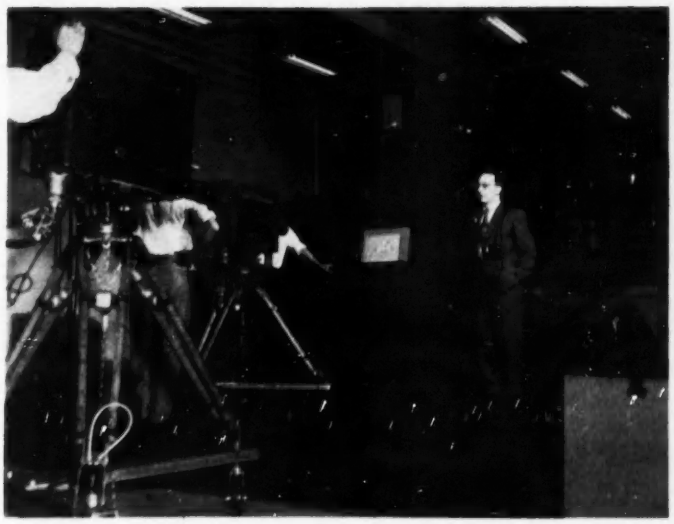
SAE Gets Axle Tester Preview via Video

More than 700 SAE members and guests sat in the auditorium of the Rackham Memorial Building on Monday, January 12, and watched the operation of a new electronically controlled axle dynamometer at the Timken-Detroit Axle plant five miles away.

The demonstration came to them on a 14 x 20-ft screen by television, transmitted over a closed circuit by microwave.

This live telecast was the first ever to be integrated with the technical meeting of a professional engineering society. Earl B. Stavely, Jr. (above) of General Electric, explained the design and operation of the dynamometer and allied equipment, which was built by his company. Both he and Roy Roush, of Timken-Detroit, while at the plant, carried on a two-way discussion with engineers in the audience at the Rackham.

Overheard as the enthused audience filed out of the auditorium: "What'll they think of next?"



slow rate, which isn't typical of highway operations. Staveley advised that this was necessitated by the TV equipment. Running the current up to 1200 to 1500 amp would completely mess up the TV picture. So armature current had to kept down, which limited the amount of accelerating torque available for the demonstration.

"Construction and Operation of Braking Testing Dynamometers" report of SAE Brake Subcommittee No. 3 presented by R. K. Super, Timken-Detroit Axle Co., committee chairman.

THIS paper is an elaboration of the basic information given in the SAE Standard Test Code for Brake Dynamometers, which will appear in the 1953 SAE Handbook as a recommended practice.

The report includes reference information that could not be included in the code either because of limited space or because of the dating of the code through its use.

The accumulation of supplementary data of a specific nature relating to inertia brake dynamometers is believed to be extremely valuable and important to all users of the code.

The following subjects are covered in the report:

1. Brake dynamometer—design features.
2. Brake dynamometer—instrumentation.
3. SAE Test Code—general features.
4. Correlation of dynamometer and road tests.

The committee feels that it will be impossible to follow the code to the letter, as the design characteristics of the dynamometers, as well as the brake design and end use, will necessitate variations in procedure with subsequent deviations in the code.

The code will, nevertheless, serve to act as a guide in securing information on operational characteristics of brakes and component parts and, by introducing a uniformity of test preparation and procedure and compilation of data, a comparison of brake performance can more readily be accomplished.

In this sense, the recommended data forms and curve sheets will permit a presentation of brake data following the pattern that has been in use for years on automotive engine testing, where standardized forms list comparable engine performance characteristics.

"Engine-Cylinder Pressure Measurements" by J. D. McCullough, Ethyl Corp.

THIS paper is intended as a guide for those contemplating making engine-cylinder pressure measurements for the first time.

The first problem to be faced is that of selecting the operating technique that will best serve the purpose of the particular test under consideration.

The author points out that there are two categories available:

1. Instantaneous pressure recording.
2. Point-by-point pressure recording.

Instantaneous recording includes the recording of a complete history of engine-cylinder pressure (as plotted against crank angle or time) for one engine cycle. This curve is usually displayed continuously on a cathode-ray oscillograph.

Point-by-point recording measures the cylinder pressure at one particular crank angle for each revolution of a 2-stroke engine or for each two revolutions of a 4-stroke engine. It may thus require thousands of point-by-point measurements to delineate the same curve shape as was recorded by the instantaneous indicator.

Point-by-point measurements have the advantage of being much more accurate than the instantaneous. The instantaneous indicator, on the other hand, gives a rapid accumulation of qualitative data and is also able to indicate rapid changes in pressure, such as are present during detonation.

The second problem to settle is, what instrument shall be used in the tests. This is not an easy task, according to the author, for there are many commercial instruments from which to choose.

The author discusses some of the criteria that must be considered in making this decision.

In general, the author points out that there are three factors governing the choice of equipment and techniques for an individual problem:

1. The purpose of the test.
2. The precision desired of the test results.
3. Configuration of the combustion chamber and engine.

Finally, the dangers inherent in some common assumptions and shortcuts are discussed to illustrate the need for continuous appraisal of test methods, even by veteran users of engine indicator equipment.

Simon K. Chen, International Harvester Co., discussed some of the problems encountered in making pressure measurements.

He pointed out, for instance, that to obtain a useful and reliable pressure-time diagram, the faithful indication of the crank angle signal is as important as that of the pressure signal.

He told of the trouble they had encountered with one of the commercially available crank angle indicators of the magnetic pickup type marker. In their installation, a flexible coupling was used to connect this marker unit to the engine crankshaft. It was found that at a certain speed the out of phase of the marker was sometimes as large as 5 deg of crank angle. This will shift the pressure curve 5 deg with respect to the time axis, he said,

giving an error of about 150 psi at tdc, since the pressure rate is around 30 psi per deg.

To minimize an error of this sort, he continued, the marker should be rigidly connected to the crankshaft, assuming that the crankshaft itself is not subject to torsional vibration.

"Measuring Rate of Fuel Injection in an Operating Engine" by R. J. Wehrman, H. R. Mitchell, and W. A. Turunen, GM Research Laboratories Division.

THE method and instrumentation developed to give the following three characteristics of injector performance are described:

1. Rate of fuel injection.
2. Fuel injection timing.
3. Injection pressures.

The aim of the investigation was to measure fuel injector performance in a firing engine simultaneously while obtaining other pertinent engine data, such as the cycle pressure-time curve.

Actually, the method was developed for use with the General Motors unit injector, but, the authors say that it may, with suitable modifications, be applied to other injection equipment.

Basically, the method of measuring rate of fuel injection used treats the spray tip holes as a flow metering element. The curve of injection pressure versus time is measured by means of a strain gage for a representative cycle, from which the fuel injection rates are obtained using a suitable pressure versus fuel flow rate calibration.

Typical injector performance data obtained with this method are also included.

The development of a reliable method for measuring the rate of fuel injection in an operating engine will allow an opportunity to determine more accurately what the engine wants in the way of injection rates, according to Stanley J. Kranc, Caterpillar Tractor Co. Then, he said, the fuel injection system can be modified in an effort to satisfy those wants.

He suggested that this method might provide a better correlation of bench test data with engine data. He said this might be the case if this method could be used in a bench test setup with the fuel being injected into a chamber pressurized at a constant level with an inert gas.

William S. Shade, GMC Diesel Equipment Division, described the collecting cell method of measuring the rate of fuel injection. A close comparison of the two methods indicates that the rate of fuel injection can be measured accurately by either the collecting cell method or by using the strain gage on the spray tip. For bench test work, he suggested, however, that the collecting cell is more simple and direct; for fuel injection studies—in which the effects of engine cylinder conditions are to be included—it is necessary to use the strain-gage method.

Now that it is possible to measure the pressures in the nozzle tip accurately, P. G. Burman, American Bosch Corp., pointed out that it is a logical step to attempt to calculate the rate of discharge from the instantaneous injection pressure diagrams and flow characteristics of the nozzle. He said that they had also tried this, first using the steady-pressure flow characteristics of a nozzle. They found the results to be in error, but not to the extent mentioned in the paper, probably because of the lower injection pressures in their case. In general, though, they still prefer the more direct and quicker method of measuring the rate with a rotating collector.

"A Method for Identifying Preignition" by R. F. Winch and F. M. Mayes, Sun Oil Co.

PREIGNITION can now be detected simply and accurately. A method has been devised that is suitable for use with single-cylinder and multicylinder engines, both in the laboratory and on the road.

The method is so sensitive that mild preignition is easily identified no matter where in the combustion chamber it originates. Since the indications are unaffected by detonation, one can easily distinguish between preignition and detonation.

It is even possible to identify which cylinders of a multicylinder engine are preigniting and to estimate the approximate location of the preignition source.

The new method is based on the fact that the electrical properties of the spark-plug gap will vary depending on (1) the time in the cycle at which combustion is initiated and (2) the rate at which the combustion process is completed, that is, whether or not secondary flame fronts are present.

Specifically, changes occur in the conductivity of the gap, which are reflected in variations in current flow. When observed on an oscilloscope, these variations serve as an excellent means of detecting the presence of abnormal combustion.

To utilize this principle to best advantage, the normal flow associated with the spark discharge has been supplemented by a constant d-c voltage across the gap. The difference between the current flow pattern produced on the oscilloscope during a preigniting cycle and a normal combustion cycle is great enough so that the change from the normal pattern is easily seen. Detonation, on the other hand, does not disturb the normal pattern unless it is very severe.

Briefly, the method is said to have the following advantages:

1. Simple, easy to construct and operate, and comparatively inexpensive.
2. Applicable to single-cylinder and multicylinder engines in the laboratory and on the road.
3. Easy to install, with no mechanical modifica-

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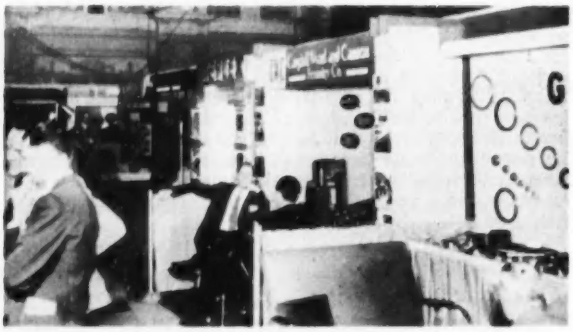


Exhibitors at the

Aeroquip Corp.
Aluminum Co. of America
Aluminum Industries, Inc.
American Bosch Corp.
Auto Specialties Mfg. Co.
Bendix Aviation Corp.
Brush Development Co.
The Buda Co.
Campbell, Wyant & Cannon Foundry Co.
Cities Service Petroleum, Inc.
Cleveland Graphite Bronze Co.
Consolidated Engineering Corp.
Continental Motors Corp.
Cummins Engine Co.
Detroit Aluminum & Brass Co.
Allen B. Dumont Laboratories
Duolac Drive, Inc.
Elastic Stop Nut Corp. of America
Fram Corp.
The Garlock Packing Co.
Gemmer Mfg. Co.
General Plate Div., Metals & Controls Corp.
Heli-Coil Corp.
Hercules Motors Corp.

Engineering Display

Koppers Co., Inc.
LeRoi Co.
Link Engineering Co.
Lisle Corp.
Lord Mfg. Co.
The MB Manufacturing Co.
McQuay-Norris Mfg. Co.
Monroe Auto Equiupment Co.
The Novi Equipment Co.
Ramsey Corp.
Redmond Co., Inc.
Ross Gear & Tool Co.
Sparks-Withington Co.
Spencer Thermostat Div., Metals & Controls Corp.
Spicer Mfg. Division, Dana Corp.
Stewart-Warner Corp.
Sun Electric Corp.
Titeflex, Inc.
Torrington Mfg. Co.
Vickers, Inc.
Victor Mfg. & Gasket Co.
Waldes-Kohinoor, Inc.
Waukesha Motor Co.
Zollner Machine Works

tions being necessary on the engine.

4. Sensitive to mild preignition, regardless of the location of the source.

5. Able to distinguish between preignition and detonation.

6. Capable of producing accurate and reproducible results.

Fred Bowditch of GM Research pointed out the importance of proper instrumentation. In their tests they had found that some resistors won't work and only certain oscilloscopes will give the type of trace shown by the authors.

D. R. Diggs of du Pont said their investigations showed that the type of engine, particularly the combustion-chamber shape, had a marked effect on the ionization pattern obtained.

"A Low-Temperature Sludging Test" by J. G. McNab, M. E. Conn, D. S. McArthur, and K. L. Stehle, Esso Laboratories.

A NEW test for evaluating the sludge handling ability of lubricants is described. With this test the sludge handling ability of lubricants is measured in terms of the time required to reach 50% oil screen plugging in cyclic laboratory engine operation. The manner in which sludge builds up in this test is similar to the way in which it builds up in field engines. Results correlate very well with those obtained in low-temperature, stop-and-go field service.

The test conditions were chosen after studying the conditions found to be conducive to sludge formation in the field.

A 6-cyl, overhead-valve engine is modified by enlarging the piston-ring gaps to increase blowby. It is then run in 4-hr cycles. Each cycle includes 1½ hr of idle with 115 F oil temperature and 2 hr of loaded operation with 180 F oil temperature. This is followed by a ½-hr shutdown under cold conditions.

Periodic inspections of the oil screen are made as the test progresses and after the per cent oil screen plugging is plotted against time. Lubricant sludging "life" is the time required to reach 50% plugging. Comparisons between lubricants are made on the same fuel.

Actually, the procedure is merely a screening test, and not a complete substitute for field tests. It is still necessary to evaluate promising experimental oils in the field. The test does have certain limitations.

A. C. Pilger, Tide Water Associated Oil Co., suggested an additional feature that might be incorporated in the sludging test to increase its application and usefulness. He said that if the field pattern of hydraulic lifter sticking can be related to varnish deposits on piston skirts, cam followers, or hydraulic lifters in a laboratory engine test, then this feature should be considered along with oil screen blocking for predicting field performance of oils in light service.

The well-known fact that crankcase oils must have the proper combination of a large number of properties was emphasized by H. C. Mougey of GM Research Laboratory Division. In other words, just because a test gives a deposit that resembles a deposit that may be found in an engine in actual service, one should not conclude from this fact alone that the oil that makes a good showing in the test is a satisfactory crankcase lubricant in actual service.

L. A. McReynolds, Phillips Petroleum Co., pointed out that a CFR CLR group is interested in the overall problem of engine deposits in field equipment.

Systems Approach . . .

. . to analysis of military equipment expounded by Air Force and Navy men.

MILITARY equipment problems are being solved by considering the item in question as part of a system for doing a given job and studying the whole system.

Experts in varied fields—such as aerodynamics, physiology, and flying—dig out data pertinent to the system. Then mathematicians apply probability theory, statistical analysis, and other of their techniques to arrive at an answer to the problem.

This "systems approach" was explained Thursday evening in a pair of papers presented at an Aircraft Activity session. (Extensive excerpts from the two papers appear in a feature article beginning on page 60 of this issue.)

"A Designer's View of Combat Aircraft Reliability" by Ivan H. Driggs and John E. Forry, U. S. Navy Bureau of Aeronautics

ANALYSIS of the airplane as a system shows that parallel duplication of equipment isn't always the best way to increase overall reliability.

Duplication increases maintenance needs. Where, under combat-area conditions, all the time and personnel available for maintenance are already being used on non-duplicated aircraft, there's no more of either to apply to duplicated aircraft. Therefore,

reliability of the duplicated items must be higher to keep availability of the airplane at the same level.

That means that if an item on an airplane is to be duplicated, it should be of better quality than if it were not to be duplicated. For example, analysis of an 80% reliable item in a fighter of 85% availability showed that if the item were to be duplicated, reliability of the item would have to be increased to 90% to maintain airplane availability at 85%.

Duplication not only increases maintenance needs—it increases weight, thereby decreasing performance. Instead of duplicating equipment, designers should seek improved reliability through better quality and simplification and possibly through more conservative design.

Today's planes seem to be more available and reliable than those of the last war, said Richard Hutton, of Grumman Aircraft. The F6F had an availability of about 80 to 85% during World War II. The F9F series airplane has over 90% availability today.

Hutton maintained that one way to improve airplane reliability—and it's out of the designer's hands—is in maintenance. Crews need better education, especially in proper use of tools. It's a pretty apparent need, since factory-maintained planes show much greater reliability than those operating under service conditions.

Richard Degan, of McDonnell Aircraft, felt that lack of spare parts contributes even more to nonavailability than spotty maintenance. Some items can't be designed for 100% reliability. So replacements for them should be readily available.

Reliability through parts simplification isn't an easy path, continued Degan. First, it's not glamorous and seldom brings recognition for the simplifier. Second, it takes time. In the airplane business things move so fast that by the time you are in a position to start simplifying one airplane you have to be designing its successor.

Frank Piasecki, of Piasecki Helicopter, urged a look at simplicity of processing as well as design. In the old days, he said, we would use three or four thicknesses for a part subjected to a gradually diminishing load. Today we do the same thing with tapered sections and eliminate joints.

"The Systems Approach to Air Weapons Development" by Major-Gen. D. L. Putt, USAF Air Research and Development Command

THE Air Force considers that it has four air weapons systems: the strategic air, air defense, tactical air, and air transport systems. Alternative equipment for each is analyzed on a systems basis. And the alternative chosen is developed and produced that way. To insure that everything comes out even at the end of the system assembly line, all components of the system—from spark plugs to trained personnel to air bases—are scheduled together to be ready, available, and operational at the proper time.

The systems approach is carried even into the contracting. The Air Force is now trying to give more and more of the complete system to one contractor, making him responsible for the complete systems integration and subcontracting.

The Air Force hopes that the entire aircraft industry will interest itself in the systems approach concept and look for opportunities to apply it.

It's generally true that jets have 20% better availability than piston engines, Putt replied to a question from SAE Past-President A. T. Colwell. And the military have good statistics for comparison.

Frank Piasecki, of Piasecki Helicopter, wondered how the systems approach is followed by the Air Force in, say, a guided missile . . . where does the ramjet end and the missile begin?

It's pretty much a matter of good judgment, said Putt. In such a case the guided missiles contract would be given to the missiles maker (probably an airframe manufacturer) and he would work it out with the manufacturer of the propulsion unit. As a matter of fact, Boeing has just such a contract with the Air Force.

The General also advised that the Air Force is aiming to lay down broad performance specifications and military characteristics in awarding contracts for new equipment, rather than detailed specifications.

The Studebaker Chorus, led by Ethel Stuart Gaumer, entertained the dinner guests prior to the speaking program. They were enthusiastically received, as were their soloists, Virginia Stuart and Barbara Buettell

About

D. C. GASKIN has been elected president of the Studebaker Corp. of Canada, Ltd., Hamilton, Ont. Gaskin, last year's chairman of Canadian Section, first joined Studebaker in 1931 as a district manager in Canada. In recent years he has been vice-president and general manager of the Canadian company.

JAMES D. MOONEY has been elected president of the F. L. Jacobs Co., Detroit. Mooney, formerly president of General Motors Overseas Corp. and an executive vice-president of General Motors Corp., was chairman and president of the Willys-Overland Motor Co. from 1946 to 1949.

DR. HAROLD GERSHINOWITZ has been appointed president of Shell Development Co. A vice-president of Shell Oil Co., Dr. Gershinowitz has been head of the exploration and production branch of research, with headquarters in Houston, Texas. As president of Shell Development, he will move his headquarters to New York City.

DR. FLOYD L. MILLER has completed his year's assignment in Washington, D. C., as vice-chairman of the research and development board of the Department of Defense and has returned to Standard Oil Development Co., New York City, as manager of the contract, legal and patent department. Prior to his Washington assignment, Dr. Miller was head of Standard Oil Development Co.'s research division.

PAUL W. RHAME, who has been serving as assistant general manager of GMC's Allison Division, Indianapolis, has been named general manager of the corporation's New Departure Division at Bristol, Conn. Rhame has been with General Motors since joining the AC Spark Plug Division in 1932.

JOHN HAMILTON has been named vice-president in charge of sales of the United Specialties Co., Chicago. Hamilton, who has been with the company for 19 years, was previously sales manager of the air cleaner division.

ARCH A. WARNER has been appointed president and general manager of Mechanics Universal Joint Division of Borg-Warner Corp., Rockford, Ill. He succeeds **G. C. GRIDLEY**, president of the division for the past ten years. Gridley will continue in a consulting capacity.

Warner was previously president and general manager of the Rockford Clutch Division of Borg-Warner. He joined Borg-Warner in 1938 as a sales engineer in the Detroit office of Mechanics Universal Joint Division.

GEORGE M. HOLLEY, JR., has been elected president of Holley Carburetor Co., Detroit. He was previously executive vice-president. **GEORGE M. HOLLEY, SR.**, is chairman of the company's board of directors. The company recently celebrated its 50th anniversary (see SAE Journal, January, 1953, page 83).

GEORGE J. SCRANTON has been named manager of the office of quality control at the Aircraft Engine Division of Ford Motor Co., Chicago, Ill. Scranton was formerly manager of the standards and methods department on Ford's manufacturing staff in Dearborn, Mich.

WILLIAM E. JUDD has been named assistant to the president and chairman of Stewart-Warner Corp., Chicago, Ill. Judd has been general sales manager of the South Wind Division of Stewart-Warner since 1949, and has been with the corporation since 1942.

J. R. FREI, former president of General Laboratory Associates, Inc., Norwich, N. Y., is now manager of product engineering for Ford Motor Co. in Ypsilanti, Mich.

Members

DAVID I. DILWORTH, JR., has been named to the newly-created post of assistant director of metallurgy with Crucible Steel Co. of America. He was previously chief metallurgist at the company's Sanderson-Halcomb Works in Syracuse, N. Y.

EDWARD R. DALEY has joined the Edward R. Bacon Co., San Francisco, as a salesman. Daley was formerly assistant regional manager for Cummins Engine Co., Inc., in Los Angeles.

C. W. KALCHTHALER has been named assistant to **J. R. GILMARTIN**, general sales manager of GMC's Hyatt Bearings Division, Harrison, N. J. Kalchthaler was previously assistant manager of the division's sales office in Detroit.

LESTER H. KEIM retired from his post as vice-president of the Oil Well Supply Division of United States Steel Co., Dallas, Texas, on Jan. 1.

ELLIOTT M. ESTES, formerly chassis engineer, has been appointed body engineer for GMC's Oldsmobile Division, Lansing, Mich. Estes came to Oldsmobile in 1946 after seven years with the GM Research Laboratories in Detroit.

DAVID J. DUNLOP retired Jan. 1 as general plant superintendent of GMC's Pontiac Motor Division, Pontiac, Mich. He has been with Pontiac and General Motors for more than 29 years, and has been general plant superintendent for the past five years.

CLARENCE L. NEWBY has retired from the post of manager of the western division sales office, Chicago, of GMC's Hyatt Bearings Division, Harrison, N. J. He has served the division for 34 years in various sales capacities. Newby will be succeeded as manager of the western division sales office by **FRANK H. WEBSTER**, who was previously assistant manager. Webster joined the division 27 years ago at the Pacific coast office.

JAMES L. KINSEL is now with the Arabian American Oil Co. in Dhahran, Saudi Arabia. He previously served with Holmes and Narver, Inc., and Van Dyke and Barnes, both of Los Angeles, as principal engineer.

L. W. TREES, service manager of Scintilla Magneto Division of Bendix Aviation Corp., was elected president of the Aviation Distributors and Manufacturers Association at the Association's recent 10th annual convention in Miami, Fla. Trees has served as a vice-president of the ADMA for the past two years.

FRED A. SAWYER has been appointed development manager of the footwear and general products division of United States Rubber Co. He will make his headquarters at the company's Mishawaka, Ind., plant. Sawyer was previously assistant manager of the division he now heads. He has been with the company since 1939.

New Executive Engineers, Chief Engineers Named at Chrysler

Ackerman

Herreshoff

Kent

Lamb

Slack

Thomas

Promotion of 12 SAE members in the engineering division of Chrysler Corp., Detroit, was announced recently by **JAMES C. ZEDER**, vice-president of Chrysler and director of engineering and research. Six former chief engineers were named executive engineers, and six assistant chief engineers became chief engineers.

New executive engineers, all previously chief engineers of their sections, are: **P. C. ACKERMAN**, laboratories; **A. G. HERRESHOFF**, development design; **P. J. KENT**, electrical; **E. P. LAMB**, truck engineering; **F. W. SLACK**, chassis design; and **U. L. THOMAS**, body engineering.

The six former assistant chief engineers, who now become chief engineers, are: **H. E. CHESEBROUGH**, body engineering; **A. G. LOOFBOURROW**, chassis design; **I. C. McKECHNIE**, electrical; **KARL PFEIFFER**, laboratories; **S. J. TOMPKINS**, truck engineering; and **C. C. UTZ**, ordnance.

Kyes Named Deputy Secretary of Defense

ROGER M. KYES, vice-president of General Motors Corp. and general manager of GMC's Truck and Coach Division, was named Deputy Secretary of Defense by President Eisenhower shortly before Inauguration Day.

Kyes, a graduate of Harvard University, joined General Motors in 1948 as executive in charge of schedules and procurement. He was named assistant general manager of the Truck and Coach Division in 1949, and in 1951 became general manager of the division and a vice-president of the corporation. Before coming to GMC, he was president of the Empire Plow Co. and held executive posts with several other companies.

HOWARD F. STEINER of the Army's Corps of Engineers is now stationed at Sharpe General Depot, Lathrop, Calif., as engineer regional maintenance representative. He was previously chief of the maintenance division, supply section, at Atlanta General Depot.

HOWARD A. GRANT is now field service representative in New York City of the electronics division of General Electric Co., Syracuse, N. Y. Grant was previously with the New York State Department of Public Works as air conditioning designer.

NORMAN C. ZOLLAR has been promoted to take charge of purchase engineering for the Lincoln Electric Co., Cleveland, Ohio. Zollar has been with Lincoln's purchasing department for six years, most recently as manager of electrode division purchases.

LEWIS B. EBBS has joined Robbins and Burke, Inc., refrigerator truck body manufacturers of Cambridge, Mass. He was formerly manager of Superior GMC Truck Co., Somerville, Mass.

P. H. SCHWEITZER is now a partner in the Schweitzer and Hussman Engineering Office, State College, Pa. Schweitzer also continues as professor of engineering research at the Pennsylvania State College in State College.

JAMES W. MARTIN has been appointed manager of the B. F. Goodrich Co.'s Salt Lake City replacement tire district. He has been acting manager there since last April, and has been with the company since 1934.

THEODORE D. PRATT has retired from the presidency of the New York State Motor Truck Association, New York City, and now resides in Hialeah, Fla.

JOSEPH GESCHELIN, Detroit editor of Automotive Industries, will present a talk on the influence of postwar automotive product design and mass production techniques on the design of machine tools before the Rockford Industrial Marketers (NIAA) in Rockford, Ill., on Feb. 10.

J. J. BONNEAU is now with the Foltz Motor Co., Minocqua, Wis. He was previously marine mechanic at Bosactis Boat House in Minocqua.

AMOS E. NEYHART, administrative head of Institute of Public Safety at the Pennsylvania State College, State College, Pa., has announced that the 8th annual Motor Vehicle Fleet Supervisor Training Course will be held in State College the week of March 23-27. Among the topics covered will be vehicle fuels, lubricants, shop layout, selection of proper equipment, maintenance, and training and supervision of personnel.

A. GEORGE W. BROWN retired Jan. 1 from his posts as transportation engineer for Schenley Industries, Inc., Lawrenceburg, Ind., and assistant director of purchases for Schenley Distillers, Inc., Cincinnati. He will continue to serve both companies in an advisory capacity.

H. J. BUTTNER is now back at his post as professor of automotive engineering at Purdue University. During 1952, Buttner served as executive assistant at Continental Aviation and Engineering Corp., Detroit, for eight months.

CHRISTIAN H. WILL, JR., is now chief designer and assistant chief engineer for the outboard motor division of the Chris-Craft Corp., Grand Rapids, Mich. Will was formerly a designer for the Holley Carburetor Co., Detroit.

ERNEST CHARLEBOIS is now senior design engineer for the general design section of Consolidated Vultee Aircraft Corp., San Diego, Calif., working on aircraft hydraulic and pneumatic equipment. He was previously a chassis design layout man for Ford Motor Co., Dearborn, Mich.

JOSEPH M. MATHER has joined Allis-Chalmers Mfg. Co., Milwaukee, as designer in the engineering department of the tractor division. He was previously vice-president of the Mountain Empire Mfg. Co. in Murray, Utah.

CHARLES O. WALLIN is now with the new products development section of Wetmore Hodges and Associates, Redwood City, Calif. He was previously with the Kaiser-Frazer Detroit Engine Division as electrical engineer in the product development department.

MARTIN P. SCHIRA, JR., is now field service representative for the service division of Wright Aeronautical Division of Curtiss-Wright Corp., Wood-Ridge, N. J. He was formerly foreman and troubleshooter for Wright's assembly department.

OSCAR W. SJOGREN retired Dec. 31 after 24 years with the John Deere Killefer Co., Los Angeles, Calif. Sjogren has served as head of the experimental department, sales manager, and special representative for the company. Before joining Killefer, he was head of the Department of Agricultural Engineering at the University of Nebraska. A past-president of the American Society of Agricultural Engineers, Sjogren has been an SAE member since 1919.

SIDNEY B. SHAW has retired as automotive engineer in charge of motor vehicles for Pacific Gas and Electric Co., San Francisco, after serving the company since 1912. When he became head of the automotive department in 1923, the company had 800 vehicles; it now operates more than 5000 pieces of automotive equipment. Shaw, who was chairman of Northern California Section in 1928–29, was presented with a life membership in SAE as a retirement present from his fellow employees at Pacific Gas and Electric.

GEORGE C. PRILL has been named technical director of the Aircoach Transport Association, Inc., Washington, D. C. Prill was formerly with the Civil Aeronautics Board in Washington as flight operations specialist for the Air Carrier Division.

ROGER SHIVELY has been released from the Army, where he served as first lieutenant in the Corps of Engineers, and is now a graduate student engineer at the Westinghouse Educational Center of Westinghouse Electric Corp., Pittsburgh, Pa.

ARTHUR KAPLAN is now general manager of the Metro Precision Grinding Corp., New York City. He was formerly works manager for the New Rochelle Precision Grinding Corp. in New Rochelle, N. Y.

LUCILLE J. PIETI has joined Chrysler Corp., Detroit, as a technical specialist in the department of technical data and information. Miss Pieti was formerly a technical writer for Ward's Automotive Reports in Detroit.

THEODORE T. CORRELL is now purchasing agent and materials and supplies supervisor for United Transportation Equipment Corp., Redwood City, Calif. He was previously operations manager of the Holman Transfer Co., Portland, Ore.

KJELL O. NILSSON has been named assistant works manager for Witte Engine Works, Kansas City, Mo. He was formerly assistant manager of the manufacturer's sales department of American Bosch Corp., Springfield, Mass.

ALLEN P. BLADE of the Munitions Board of the Department of Defense received a certificate for the completion of two years of courses at the Officers Reserve Corps School at Fort Myer, Va. The certificates were presented at ceremonies Jan. 10 marking the second anniversary of the school. Blade holds a lieutenant colonel's commission in the Reserve.

Becomes Consultant to Gulf

R. J. S. PIGOTT became a consultant to Gulf Research & Development Co. following his retirement as that organization's director of engineering on January 1, 1952. Pigott was SAE president in 1948 and president of the American Society of Mechanical Engineers in 1952. He is also a past president of the Instrument Society of America and the American Society for Measurement and Control. He holds more than 30 patents on devices used in hydraulic engineering, heating, oil production, and instruments—including his most recent, Hi-Jet, a new method of lubricating and cooling tools in metal cutting. He had completed 23 years of service with Gulf at the time of his retirement.

NEWELL P. BECKWITH has been appointed vice-president and technical director of the Rinshed-Mason Co., Detroit. He was previously director of research for the company. Except for a four-year term as an Army Ground Forces staff officer, Beckwith has been with Rinshed-Mason since 1940.

WILLIAM C. HALE, JR., has been elected vice-president of the South Chester Corp., Lester, Pa. Before joining the organization in 1941, Hale was with Gulf Oil Corp., Tulsa, Okla. He has been South Chester's manager of operations since 1946.

ROY E. MAYO has been transferred to the headquarters of Caterpillar Tractor Co. in Peoria, Ill., as research staff engineer. He was previously at the company's offices in San Leandro, Calif., as supervisor of western division field research activities. He has been with Caterpillar since graduating from the University of California in 1930.

VICTOR JANTSCH, truck engineer for the engineering department of GMC Truck and Coach Division, Pontiac, Mich., is retiring from his post with the division. Jantsch has been an SAE member since 1912.

PAUL E. HITCH has transferred to GMC's Chevrolet Motor Division in Detroit as development and test engineer. He was previously senior design engineer at the Chevrolet Aviation Engine Division, Buffalo, N. Y.

CARL F. PHILLIPS is now service engineer for the Lix Corp., Kansas City, Mo. He was previously senior mechanical design engineer for Black and Veatch, consulting engineers, in Kansas City.

WILLIAM D. GAUTHIER has joined the Ransburg Electro-Coating Corp., Indianapolis, Ind., as project engineer. He was formerly research engineer at GMC's Research Laboratories Division.

J. G. WATTERS, who was previously layout designer at John Deere Dubuque Tractor Works, Dubuque, Iowa, has joined the engineering department of Pioneer-Central Division of Bendix Aviation Corp., Davenport, Iowa as designer.

CHARLES M. WEBB is now with U. S. Royal Tire Service, Inc., St. Louis, Mo., as fleet engineer. He was formerly fleet engineer for Rudy and George, Inc., in St. Louis.

O. L. BRYAN is now a stress analyst for Beech Aircraft Corp., Wichita, Kans. Bryan was formerly design checker in the tool engineering department of Chance Vought Aircraft Division of United Aircraft Corp., Dallas, Texas.

WALTER E. SCHIRMER, vice-president of the Industrial Truck Division of Clark Equipment Co., Buchanan, Mich., was elected second vice-president of the Material Handling Institute on Dec. 18 at the annual meeting of the Institute in New York City.

DALE E. KISTLER has joined Lockheed Aircraft Co., Burbank, Calif., as research engineer. He was previously aeronautical engineer at the aeronautical engineering laboratory of the Navy's Naval Air Materiel Center, Philadelphia, Pa.

ARTHUR B. COOK is now technical analyst with the flight test department of McDonnell Aircraft Corp., St. Louis, Mo. He was previously a research and development officer at the Air Force's Wright Air Development Center, Dayton, Ohio.

HARVEY S. FIRESTONE, JR., was cited as an outstanding churchman, businessman, statesman and humanitarian by the National Conference of Christians and Jews on Dec. 8 at a dinner given in his honor by the Automotive Division of the Conference in New York City.

RICHARD E. MOORE is now a mechanical engineer for Hughes Aircraft Co., Culver City, Calif. He had previously been with GMC's Aeroproducts Division, Dayton, Ohio, for nearly 12 years.

PAUL R. NAU is now experimental engineer for the Clinton Machine Co., Maquoketa, Iowa. He was previously assistant experimental engineer for Wisconsin Motor Corp., Milwaukee, Wis.

DAVID A. GORTE, who was previously a draftsman for the Dodge truck design section of Dodge Brothers Corp., Chrysler Corp., has been transferred to the contact engineering group at the Dodge Truck Plant, Detroit.

MAX DACH is now superintendent of maintenance, western region, for Associated Transport, Inc., New York City. He was previously superintendent of maintenance for the Ohio Valley Bus Co., Huntington, W. Va.

EDWARD A. DRURY is now project engineer, development engineering, for the jet division of Thompson Products, Inc., Cleveland, Ohio. Drury was formerly an analytical engineer for Power Generators, Ltd., Trenton, N. J.

JOHN F. KOPCZYK has returned to the Buda Co., Harvey, Ill., as draftsman after nearly two years with the Army's Corps of Engineers. Kopczyk was assigned to the Korean Military Advisory Group as chief draftsman.

Students Enter Industry

PATRICK J. TOBIN (Parks College '51) is a second lieutenant in the U. S. Air Force in pilot training at Goodfellow Air Force Base, San Angelo, Texas.

DAVID W. COGSWELL (Massachusetts Institute of Technology '52) has joined the Electric Regulator Co., Norwalk, Conn., as electrical and mechanical engineer.

STANLEY B. MURPHY (California State Polytechnic College '52) is now in training with Westinghouse Electric Corp., Pittsburgh, Pa.

ARTHUR A. ZERRY (Parks College '52) is an engineering technical writer for Boeing Airplane Co., Wichita, Kans.

THOMAS W. ALLES (Purdue University '51) is now in the U. S. Air Force. Captain Alles is assigned to the University of Iowa as assistant professor for the Air Reserve Officers Training Corps.

CARL T. DANIELS (Ohio State University '52) is in the Air Force at the Aircraft Maintenance Officer Training School at Chanute Air Force Base, Ill.

RICHARD J. CORBETT (University of Colorado '52) is plant engineer for Timberline Fabrics Co., Denver, Colo.

JOHN F. THORNE, JR. (Purdue University '52) has joined the Research Laboratories of General Motors Corp., but is now on military leave of absence to serve with the U. S. Air Force.

ALGER R. JOHNSON (Southern Methodist University '52 is an engineering trainee for Detroit Diesel Engine Division of General Motors Corp., Detroit.

ROBERT B. SPANN (Bradley University '52) is an industrial engineer for Bendix Radio Division of Bendix Aviation Corp., Towson, Md.

HARRY C. FOSTER (University of Southern California '52) is a design engineer with Hydro-Aire, Inc., Burbank, Calif.

JOHN G. KALOGERIS (Academy of Aeronautics '51) is a student pilot cadet in the U. S. Air Force.

MICHAEL MOROSO (University of Wisconsin '52) is a junior engineer for Douglas Aircraft Co., Inc., Santa Monica, Calif.

Continued on Page 131

NEWS OF SAE

pages 99—103

FINANCING . . .

. . . of SAE's Technical Committee Activities is a major operation dependent on the help of many members.

LAST year industry asked SAE for $200,000 worth of Technical Committee help. To cover the cost, the number one beneficiary, industry, generously provided $180,000 to add to the Society's $20,000—5½% of members' dues. In addition, industry provided the technical committee talent at its own expense.

A Team Is Necessary

More than 20 SAE members have their shoulders to the wheel telling industry of the need for funds and why. Under Finance Committee Chairman A. T. Colwell, who himself solicits the largest group, the other leaders each approach anywhere from 5 to 93 companies. This team takes the field as follows:

G. W. Brady	Aircraft Propellers
Charles Froesch	Airlines
E. G. Haven	Aircraft Accessories and Equipment
E. H. Kelley	Automobile Parts
R. I. Schonitzer	Body Manufacturers
V. C. Young	Aero-Ground Equipment
F. M. Marschner	Ball and Roller Bearings
H. W. Luetkemeyer	Sleeve Bearings & Non-Ferrous
Stephen Johnson	Brakes
C. E. Frudden	Tractor Manufacturers
E. F. Norelius	Construction & Industrial Machinery
W. H. Graves	Iron and Steel
H. B. Knowlton	Iron and Steel
P. R. Wray	Iron and Steel
H. W. Browall	Iron and Steel
L. L. Ferrall	Iron and Steel
R. E. Carlson	Lamp Manufacturers
P. J. Kent	Electrical Equipment
R. W. Seniff	Railroads
P. C. Ackerman	Special
E. R. Wilson	Miscellaneous
A. T. Colwell	Various

The Process

Some individual contacts are made in person, but the principal effort is by way of solicitation letters. That industry has gained a fuller knowledge of the benefits of SAE technical committee work and a better understanding of the Society is evident from the ever growing list of those who supply the funds. That the team has done its work well is apparent from the complimentary letters which enclose the checks.

There Are Others

Some who have done well in the past are J. M. Crawford, J. H. Frey, C. G. A. Rosen, William Littlewood, R. P. Lansing, M. P. Ferguson, J. W. Bridwell, Elmer McCormick, and L. R. Buckendale.

Policies Are Important

SAE restricts use of these funds to the technical committee work for which they are solicited. Furthermore, every effort is made to insure that different companies of a corporate family are informed when more than one provides support.

That such care is unique is indicated by a letter from a contributing corporation. When SAE wrote to point out that both the corporation and one of its subsidiaries had contributed, the treasurer of the corporation replied.

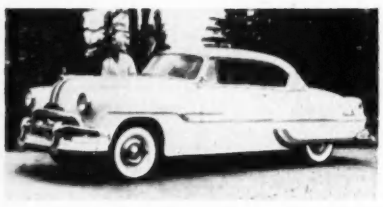
"In the years in which I have handled some of these contributions I have never had the pleasure of getting a letter like this and I want to express my appreciation . . . please by all means keep both contributions. . . ."

The SAE Technical Board, ever conscious of the "value received" policy, is a guarantee to industry that funds will be administered to best and broadest advantage.

What's New in '53 Car Trends . . . Features Like . . .

Packard's Power Steering

Plymouth's New Suspension



Pontiac's Shock Absorbers

THE driving public sees in new car announcements a series of isolated new features and fresh body changes. The automotive engineer probes deeper. He searches for trends in engineering revealed by new cars, changes in engineering approach . . . the meaning behind the advances.

That's what the SAE 1953 National Passenger Car, Body, and Materials Meeting next March will offer. And the man who'll make the analysis of technical highlights of '53 cars is SAE Past-President W. S. James, vice-president of Fram Corp. James comes well equipped to see the significance in car developments. As chief engineer at Studebaker and as director of research at Ford, he's conceived, developed, and directed many advances in passenger cars.

At the March meeting, James will analyze new automotive engineering achievements in '53 cars and extract significant trends from them. His engineering interpretation of engineering developments for engineers will be practical and objective.

He'll spot the design trends in high compression engine design, power steering, automatic transmissions, suspensions, electric systems, passenger comfort features, and many other car components.

In sponsoring this paper on new car highlights, the SAE Passenger Car Activity renews an attraction that the Society has offered in previous years.

NEXT . . .

. . . Transactions will be single, bound volume, out September, 1953.

IF you didn't order your 1953 SAE Transactions when you paid your dues, you can still ensure that you will get a copy of this valuable reference work by sending in your order by March 1—when the final print order must be established.

Transactions is now being issued only once a year, as a single, bound volume with hard cover. The 1953 Transactions will be issued in September, 1953.

Prices are: $3 to members, $7 to public and college libraries and U. S. Government agencies, $10 to nonmembers. Foreign: $3 to members, $8 to public and college libraries, $11 to nonmembers.

HELPFUL . . .

. . is the word for L.A. Production Forum, observe participants in survey.

ONE way to design a better product is to ask the people who use it what they like about it, don't like about it, and improvements they'd like to see made. That's just what the planners of the SAE 1953 Aircraft Production Forum did . . . they asked their customers, the manufacturing men who attended their 1952 Forum. Their "market" survey showed that the Forum served up in Los Angeles is pretty well tailored to needs of production men.

A sampling of 67 men of the more than 1100 that were at the Forum in Los Angeles on October 1, 1952, responded to queries. Here are the values they said they derived from attending the Forum panels:

- 27, or 40.3% said they got information that they could apply to their job.
- 38, or 56.7% said they learned how other companies approach common problems.
- 25, or 37.3% said they made

Continued on Page 108

Job Opportunities for Students

Available through the SAE Placement Service is a list of companies which employed engineering undergraduates last summer. (Application for such positions must be made early.) A directory of companies which sponsor "formal" training programs is also offered to SAE Enrolled Students. Both of these lists result from a Placement Service survey, limited to companies which use SAE Placement facilities and which agreed to publication of the information.

In addition, the Placement Service asked questions centering on:

1. The outlook for engineering graduates;
2. How their training fits into business;
3. Personality factors.

Comments received from 125 employers indicate that a good mechanical engineering course is the background for most types of specialized engineering work in the automotive field. With shortages in about every phase of the industry, the job outlook is good. Starting salaries average from $302 to $342 monthly.

Untapped Areas

It was suggested that young men consider carefully all branches of the industry—too many are emphasizing design and development and overlooking maintenance and operation —project engineering—export service—metallurgy—chemical engineering.

Employers find that excellent scholastic training is given by the colleges today. Their main criticism—and a strong one—is toward the lack of practical experience. They feel that most young men have an unfounded "aversion to the drawing board . . . the principal medium of expression for the young engineer."

Book Learning Not Enough

Lack of shop work also reflects on the ability to handle a given job. Most employers feel that this type of experience should ideally be acquired either in school or through summer employment. "While there is such a shortage of engineers, they may get by all right; but one of these days we will have a lot of unemployed 'half-engineers'."

Improvement is looked for in the average student's ability to organize work and present readable reports. "Greatest lack of most engineers is ability to write effectively and forcefully."

Employers Alert to Attitudes

A surprising number of employers find that too many young engineers have a "know-it-all" attitude. Importance of working with others and following instructions is stressed. Prime interest is in a good team—not in one young "star." Extra-curricular activities play an important part in learning to get along with others. Also . . . "suggest the inculcation of a little more patience and modesty in the first two years of working experience. A person with good potential will be better able to handle important assignments if, in addition to his formal education, he gets good grounding in the working fundamentals of his field."

One employer summed up: "Students should be informed that the degree is not a passport to success, but only a tool which they can use to achieve success."

Program for

SAE National Passenger Car, Body and Materials

March 3-5, 1953, The Sheraton-Cadillac

Tuesday, March 3

9:30 a.m. Grand Ballroom

Welcome
E. N. COLE,
General Chairman of Meeting
Chairman—F. R. McFARLAND,
Packard Motor Car Co.
Secretary—M. A. FORESTER,
Packard Motor Car Co.

Tire Safety at High Speeds
J. J. ROBSON, Firestone Tire and Rubber Co.

Safety at high speeds is being built into tires as increased horsepower invites faster highway travel. Greater responsibilities rest both upon tires and engineers, now concerned with traction waves phenomena at speeds of 100 mph and up.

Safe Brakes for Passenger Cars
G. T. LADD, Al-Fin Division, Fairchild Engine and Airplane Corp., and S. B. DEW, Wellworthy, Ltd., England.

Brake designers, squeezed by bigger engines, greater speeds, and confining bodies, increasingly are harassed by complicated problems of design and materials. Development of bonded bi-metallic brake drums shows progress.

(Sponsored by Passenger Car Activity)

2:00 p.m. Grand Ballroom

Chairman—J. L. McCLOUD,
Ford Motor Co.
Secretary—J. S. LAIRD,
Ford Motor Co.

Bumpers and Other Functional Parts —Their Materials and Finishes
D. M. BIGGE, Chrysler Corp.

Research at work! Hot-from-the-laboratory data on how to perpetuate the pristine brilliance and sparkle of motor vehicle bumpers and other bright-work.

Automobile Body Corrosion
F. L. LaQUE, International Nickel Co., Inc.

Motion Picture—Corrosion in Action —courtesy of International Nickel Co.

Body corrosion caused by atmospheric pollutents, road salts, humidity, and other sources can be prevented. Color movies, employing time-lapse photography, tell the whole story, including technical details of passivity and protective coatings.

(Sponsored by Engineering Materials Activity)

8:00 p.m. Grand Ballroom

Chairman—F. S. SPRING,
Hudson Motor Car Co.
Secretary—W. A. McCONNELL,
Ford Motor Co.

Wind Effects on Car Stability
W. E. LAY, University of Michigan, and P. W. LETT, JR., Chrysler Corp.

Research with a test car equipped with body as separate unit actually measures forces transmitted from body to chassis by sidewinds and gusts. Results suggest that body design importantly affects aerodynamic stability.

(Sponsored by Body Activity)

Wednesday, March 4

9:30 a.m. Grand Ballroom

Chairman—A. L. BOEGEHOLD,
General Motors Corp.

What Alloy Should Be Used to Die Cast Automotive Parts—Zinc, Aluminum or Magnesium?
M. R. CALDWELL, Doehler-Jarvis Corp.

Research by Dow Chemical, Chrysler, and Doehler-Jarvis shows that aluminum and zinc die castings can withstand corrosion in automotive applications. Essential factors include design for, and comparable costs of, such use.

The Major Developments in the Field of Powder Metallurgy
G. J. COMSTOCK, Stevens Institute of Technology

Fully-alloyed metal powders become high-strength, high-density, heat-treatable materials through recent developments which facilitate production, fabrication, and application.

(Sponsored by Engineering Materials Activity)

2:00 p.m. Grand Ballroom

Chairman—S. L. TERRY,
Chrysler Corp.
Secretary—ELWOOD BOLLES,
National Automotive Fibers, Inc.

Man-Made Fibers as Applied to Automotive Textiles

The Lustre Revolution
W. F. BIRD, Collins and Aikman Corp.

Revolutionary changes are resulting from the use of synthetic fabrics for automobile interior upholstery. Necessary is understanding of properties and effects achieved by proper selection from the various forms of filament and staple.

Fabric Selection and Fabrication of Man-Made Fibre Automotive Cloth.
G. P. CARVER, JR., Bachmann Uxbridge Worsted Corp.

Selection of the style, design, and color of automotive interior fabrics can be based upon facts rather than fancy, particularly in view of the availability of new synthetics.

(Sponsored by Body Activity)

8:00 p.m. Grand Ballroom

Chairman—R. F. KOHR,
Ford Motor Co.
Secretary—L. H. NAGLER,
Nash Motors Division,
Nash-Kelvinator Corp.

Engineering Highlights of 1953 Passenger Cars
W. S. JAMES, Fram Corp.

Concealed by 1953 superlatives and streamlining is some mighty smart automotive engineering. Analysis shows trends of technical thought and progress far ahead of yesterday, but only preparatory for tomorrow.

(Sponsored by Passenger Car Activity)

Thursday, March 5

9:30 a.m. Grand Ballroom

Chairman—E. H. SMITH,
Packard Motor Car Co.
Secretary—L. H. NAGLER,
Nash Motors Division
Nash-Kelvinator Corp.

Recent Developments in Air Conditioning of Passenger Cars

Automobile Passenger Compartment Cooling from the Vehicle Manufacturer's Viewpoint
P. J. KENT, Chrysler Corp.

Preliminary answers to some technical problems created by passenger car cooling, including potential market, developing systems which are small, light, simple, and reliable, tooling-up, and training personnel.

Your Car Can Beat the Heat
M. W. BAKER and D. C. McCOY, Frigidaire Division, General Motors Corp.

If your engineer can lick the complications, such as variable speeds, small space, large cooling requirements, proper circulation, heat dissipation, adequate control, and differing ideas about passenger comfort!

Production and Service Aspects of Automotive Air Conditioning
H. V. JOYCE, Ford Motor Co.

Motor vehicle air conditioning creates new installation and service problems for factory and dealers. Among them are system purging, charging with refrigerant, and test-checking for leaks, all important pre-delivery operations.

(Sponsored by Passenger Car Activity)

2:00 p.m. Grand Ballroom

Chairman—M. M. ROENSCH,
Ethyl Corp.
Secretary—E. G. MOELLER,
Chrysler Corp.

Valve Gear Problems in Modern Overhead Valve Engines

Meeting

Hotel, Detroit

Overhead Valve Gear Problems
R. P. HORAN, Eaton Manufacturing Co.

Original data on valve gear dynamics and tappet face wear. Research suggests stiffness requirements and cam design may resolve dynamics problems, alignment and residual grinding stresses ultimately curtail wear.

Calculation of High Speed Valve Motion with a Flexible, Overhead Linkage
PHILIP BARKAN, Pennsylvania State College.

This newly-developed method determines, from cam design data, the effects upon valve motion of valve lash, spring vibrations, cam irregularities, and other factors. Calculations are adaptable to digital computers.

Hydraulic Tappets, Why They Work, and What to Do If They Don't
CARL VOORHIES, Chicago Screw Co.

Simplifications sometimes lead to complications. It is wise to be prepared for emergencies. Experience suggests proper courses of action in case of tappet malfunctioning.

Valve and Valve Seat Distortion
J. A. NEWTON and M. J. TAUSCHEK, Thompson Products, Inc.

Inevitable valve and valve-seat distortion, which shortens valve life, can be curtailed. Corrective measures include valve rotation, hard facing, flexible seat inserts and valve heads, proper selection of valve steel and insert alloy.

Designing the Cam Profile for Low Vibration at High Speeds
R. A. ROGGENBUCK, Ford Motor Co.

High-speed vibration in overhead valve trains can be traced to cam profiles. Technique employing automatic computing machines provide rapid approximate predictions of results with contemplated profiles.

(Sponsored by Passenger Car Activity)

DINNER

6:30 p.m. **Grand Ballroom**

P. H. PRETZ
Chairman, SAE Detroit Section

V. A. CROSBY
Toastmaster

ROBERT CASS
SAE President

"Our Part in These Times"
Dr. J. O. Christianson

School of Agriculture
Superintendent, University of Minnesota

National Meetings . . .

Meeting	Date	Hotel
	1953	
PASSENGER CAR, BODY, and MATERIALS	March 3-5	The Sheraton-Cadillac, Detroit
PRODUCTION	March 25-27	Hotel Statler, Cleveland
AERONAUTIC PRODUCTION FORUM	April 20	Hotel McAlpin and Hotel Governor Clinton, New York City
and		
NATIONAL AERONAUTIC MEETING and AIRCRAFT ENGINEERING DISPLAY	April 21-23	Hotel Statler, New York City
SUMMER	June 7-12	The Ambassador and Ritz-Carlton, Atlantic City, N. J.
INTERNATIONAL WEST COAST	Aug. 17-19	Georgia Hotel, Vancouver, B. C.
TRACTOR and PRODUCTION FORUM	Sept. 14-17	Hotel Schroeder, Milwaukee
AERONAUTIC MEETING and AIRCRAFT ENGINEERING DISPLAY and AIRCRAFT PRODUCTION FORUM	Sept. 29-Oct. 3	Hotel Statler, Los Angeles
INTERNATIONAL PRODUCTION	Oct. 29-30	Royal York Hotel, Toronto
TRANSPORTATION	Nov. 2-4	Conrad Hilton, Chicago
DIESEL ENGINE	Nov. 3-4	Conrad Hilton, Chicago
FUELS & LUBRICANTS	Nov. 5-6	Conrad Hilton, Chicago

TECHNICAL COMMITTEE *Progress*

Today's Jets Are Hard On Fuel and Oil Systems

FUEL and oil systems on today's jet planes are being asked to do a giant size job . . . as a result they're getting tougher and tougher to design. The trend toward faster, higher-flying jets constantly introduces new problems in design.

Which of these problems can benefit from joint action by industry? What are possible solutions to them? Where should standardization be promoted?

Just as SAE committees worked out problems of air conditioning and generator selection, so a new SAE group hopes to provide some of the answers to these perplexing fuel and oil system problems. It's to be called Committee A-16, Aircraft Fuel and Oil Systems and Equipment, and Philip H. Jones, of North American Aviation, has accepted its chairmanship.

Jones comes to this job well prepared for the duties associated with it. During the war years he was power-plant project engineer on the P-51 Mustang . . . and later was in charge of the powerplant installation on North American's first jet fighter—the Navy FJ-1. Since 1947 he has been in charge of fuel system engineering for all of North American's production airplanes.

Right now, chairman Jones is assembling a group of experts from industry and the military to serve on A-16, and plans to call the first meeting of the committee early this spring.

North American's P. H. Jones—chairman of Committee A-16, Aircraft Fuel and Oil Systems and Equipment. This new group hopes to provide answers to some of the problems faced by designers of fuel and oil systems on jets

1953 SAE Technical Board

Earle S. MacPherson, Chairman
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H. E. Churchill
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R. P. Lewis
W. G. Lundquist
A. F. Meyer Jr.
C. E. Mines
M. E. Nuttila
F. N. Piasecki
E. W. Tanquary
B. G. VanZee
W. M. Walworth

Air Cleaner Test Code Gets More Tests and Pics

TRACTOR oil-bath air cleaners admittedly have a tough job to do—thus it helps to know in advance how well they are equipped to do it. The guide for this evaluation has just been approved by the SAE Technical Board for publication in the 1953 SAE Handbook. It's a completely revised version of the SAE recommended practice for laboratory testing tractor air cleaners.

Two years in the making, the new edition of the test code encompasses a variety of new tests and a dozen new illustrations. Complete procedures are now included for determining these operating characteristics of air cleaners:

1. Restriction.
2. Oil carry-over with:
   - Indicated oil level and increasing air flow.
   - Constant air flow and increasing oil level.
   - Angle operation.
   - Rocking operation.
3. Oil loss.
4. Initial wetting of elements with:
   - Indicated oil level and increasing air flow.
   - Constant air flow and decreasing oil level.
5. Efficiency with:
   - Steady and variable air flow.
6. Dust capacity with:
   - Steady and variable air flow.
7. Backfire or reverse flow.

Very little is left to the imagination in the way of illustrations, too. Diagrams show everything from a suggested transparent observation tube and variable air-flow cycle to a suggested dust-feeding mechanism, rocking-test machine, and individual test setups.

Test dust is clearly defined also. It's to be similar to dust found in the

Wayne H. Worthington, of John Deere Waterloo Tractor Works, helped make the new air cleaner test code possible. He was chairman of the group which made extensive revisions in the present SAE recommended practice

vicinity of Phoenix, Arizona and of two grades—fine and coarse. Fine dust samples are to show small differences during development work and the coarse dust is to be used to obtain results comparable to field tests.

Oil for the cleaner tests has been changed, too. Instead of SAE 40 and 10W, SAE 10 and 30 grades are now recommended.

Set up primarily for determining the operating characteristics of oil-bath air cleaners used on tractors and construction machinery, the code may later be extended to include air cleaners used on passenger cars, trucks, and buses.

Credit for developing this new package goes to the hard-working Air Cleaner Test Code Subcommittee of the SAE Tractor Technical Committee —its chairman W. H. Worthington, of John Deere Waterloo Tractor Works, and members W. O. Bechman and W. W. Henning, International Harvester; B. G. Brown and W. S. James, Fram; D. P. Eastman, United Specialties; J. P. Kovacs, Purolator Products; W. W. Lowther, Crenlo; R. J. Lunn, Donaldson Co.; S. T. McCormick, Vortex Co.; N. R. McManus, Ford; C. T. O'Harrow, Allis-Chalmers; J. W. Seiple, John Deere Waterloo Tractor Works; J. H. Smith, Caterpillar; and R. E. Thibodeau, Detroit Arsenal.

Technical Board Approves 13 AMS

THIRTEEN revised SAE Aeronautical Materials have been approved recently by the Technical Board. Copies of the specifications are available from the SAE Aeronautical Department.

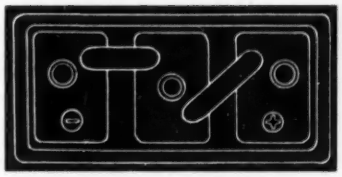
- AMS 3232F—Asbestos and Synthetic Rubber Sheet
- AMS 3420C—Dehydrating Agent;
- AMS 3552A—Fibreboard, Corrugated;
- AMS 3554A—Fibreboard, Corrugated;
- AMS 3560A—Fibreboard, Solid;
- AMS 3535B—Barrier Material, Water Vapor Resistant, Flexible, Opaque;
- AMS 3540A—Paper, Greaseproof;
- AMS 3610C—Barrier Material, Water Vapor Resistant, Flexible, Transparent;
- AMS 3921A—Plywood, Medium Density;
- AMS 3922A—Plywood, High Density;
- AMS 4083C—Aluminum Alloy Tubing, Hydraulic
- AMS 4360C—Magnesium Alloy Forgings
- AMS 6350C—Steel Sheet and Strip

These actions have been approved recently by the SAE Technical Board . . .

YARDAGE RATING DEFINITION—The definition, "heaped capacity of a truck or wagon body," in the SAE Standard for Yardage Rating has been modified as follows:

"Heaped capacity of a truck or wagon body shall be the volume enclosed by the body and by four planes at a slope of one vertical **in two** horizontal, extending upward and inward from the top edges of the side and end plates."

NEW BATTERY TYPE—To the SAE Standard on Storage Batteries has been added a new type, SAE No. 3N. This 6-v front terminal assembly type battery is for use with gasoline engines. Maximum overall dimensions are 11¼ × 5½ × 8 29/32 in.



Batteries of the SAE No. 3N type are required to have a minimum capacity of 110 amp-hr in the 20-hr test outlined in the Standard for determining the battery's ability to handle the parking lamp load.

CHANGES IN H-BAND STEEL COMPOSITIONS—The SAE Iron and Steel Technical Committee has proposed that

1. Carbon ranges for all H steels be narrowed by one point.
2. Manganese and chromium ranges be widened 10 points for all single and double alloy steels.

Now that the Technical Board has approved these proposals, the ISTC will make the appropriate changes in the hardenability bands and in the chemical composition tables.

Purpose of the changes is to give steel users the benefit of more closely controlled hardenability ranges. By narrowing the carbon range, steel producers can tighten hardenability bands, provided they have the added latitude on manganese and chromium.

AMERICAN STANDARDS—The SAE, as one of the sponsors of ASA Sectional Committee B-5 on Standardization of Small Tools and Machine Tool Elements, has approved revisions made by this group in the American Standards, "Spindle Noses and Arbors for Milling Machines" and "Machine Tapers."

Many Changes, Additions Included In Revised Aero Drafting Standards

THE fourth edition of the SAE Aeronautical Drafting Manual has just come off the press. It contains 24 revised pages and 14 pages of new material to bring the manual up to date with current industry practice.

The new material covers the following subjects:

- Wrench clearance data.
- Torsion springs.
- Interchangeability of parts.
- Contour zone tolerancing.

Revisions have been made in the following sections:

- Arrangement of views.
- Definitions.
- Twist drill data.
- Abbreviations.

Wrench Clearance Data

The new manual includes a tabulation of the clearance requirements of wrenches for hexagonal bolts and nuts.

Box wrenches, socket wrenches, and normal-duty open-end wrenches are covered for hexagonal sizes from 0.156 to 1.625, inclusive. The values listed are suitable for the majority of wrenches of the types covered that are available to the industry.

Torsion Springs

The spring section of the manual contains a new part, which provides full drafting information concerning torsion springs. It includes an example that shows the information generally required for specifying one type of torsion spring. It also contains drawings of several types of these springs.

Interchangeability of Parts

This new section describes briefly how a drawing should be dimensioned for the manufacture of interchangeable parts. It supplements similar recommendations already listed in the manual.

It contains the following material:

1. Reasons why interchangeable parts are needed.
2. The basic requirements for dimensioning for interchangeability.
3. Reasons for establishing the various relationships of surfaces. Definitions and illustrations of surface relationships are included.
4. Reasons for including tolerances.
5. Interchangeability of parts when drawings are revised.

Contour Zone Tolerancing

A section has been added to the manual to provide information on applying tolerances to contours. It is incorporated in the dimensioning part of the section entitled, "Preparation of Drawings."

The new system of applying tolerances to contours stresses the direct tolerancing of a contour rather than the tolerancing of all of the component dimensions. It is to be applied especially to parts having relatively complex contours, which otherwise would require the individual tolerancing of angles and radii, as well as locating dimensions to the centers of radii.

This system is said to have the following advantages when a uniform tolerance is desired throughout the contour of a given part:

1. It permits an exact expression of design requirements.
2. It saves drafting time.
3. It facilitates the tooling for parts —and also their manufacture.
4. It simplifies inspection.

Arrangement of Views

The "Arrangement of Views" part of the section on the preparation of drawings has been revised to include what the committee feels is a better way of describing orthographic projection.

Definitions

The section of definitions has been revised and enlarged. The new section will contain 14 more definitions than the old one.

Twist Drill Data

The twist drill data given in the Tables Section of the manual have been revised to bring the material in line with current technical requirements of the aeronautical industry.

The revisions include the following:

1. P. Y1.01 now includes all drill sizes listed in the ASA B5.12-1950 Twist Drill Pamphlet up to and including 1-in. diameter.
2. A note under this table: "Drill sizes above 1 in. are available in increments of 1/64 in. to 1¾-in. diameter, in increments of 1/32 in. to 2¼-in. diameter, and in increments of 1/16 in. to 3½-in. diameter.
3. On p. Y1.02 the tolerances on the 0.7672- to 1.000-in. diameter drill hole sizes have been changed from +0.007/−0.002 to +0.007/−0.003, and on the 1.0156- to 2.000-in. drill hole sizes the tolerances have been changed from +0.010/−0.002 to +0.010/−0.004. A line has also been added to show a tolerance of +0.015/−0.005 for the 2.0312- to 3.500-in. diameter holes. A note clarifying the use of tolerances as listed has also been added.

Abbreviations

The section on abbreviations and symbols is greatly expanded in the new manual.

The new list is the result of the combined efforts of Committee S-1 and the SAE Automotive Drafting Standards Committee to produce a set of abbreviations that is identical in both manuals.

Thus, the list as found in the Aeronautical Drafting Manual includes abbreviations for many terms not used in the aeronautical industry but that are used by the automotive industry.

The list also complies with the American Standard "Abbreviations for Use on Drawings" and the Joint Army-Navy Standard "Abbreviations for Use on Drawings."

Bring Your Manual Up to date

IF you have an SAE Aeronautical Drafting Manual, you can bring it up to date with a set of the revised pages. The cost is $2.

If you don't have a manual, you can purchase one for $4.50 without binder, and for $6.50 with leatherette silver-printed binder.

In quantities of 10 or more, the cost of the manual is $4.25 without binder and $6 with the binder.

New Chairman and Seven New Members Take Office on 1953 SAE Technical Board

EARLE S. MACPHERSON has been named chairman of the SAE Technical Board for 1953. He is vice-president of engineering for Ford and has been an SAE-named director of the Coordinating Research Council as well as a member of the SAE Technical Board.

Seven new Technical Board members were also appointed by SAE President Robert Cass to terms expiring at the end of the 1955 administrative year. They are D. P. Barnard, G. E. Burks, C. A. Chayne, H. E. Churchill, E. G. Haven, C. E. Mines, and B. G. VanZee.

Board members who continue in office are P. C. Ackerman, H. W. Browall, R. D. Kelly, R. P. Lewis, W. G. Lundquist, A. F. Meyer, Jr., M. E. Nuttila, F. N. Piasecki, E. W. Tanquary, and W. M. Walworth.

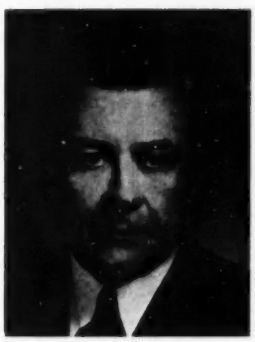
Members whose terms expired at the end of the 1952 administrative year were B. B. Bachman, G. A. Delaney, R. P. Kroon, R. P. Lansing, R. J. S. Pigott, and W. H. Worthington.

Earle S. MacPherson (right) began his career as an automotive engineer with Chalmers Motor Co. immediately after graduation from University of Illinois. Just before World War I he left Chalmers to serve on the Bolling Mission as a civilian engineer. In Europe at the outbreak of the war, he was commissioned a captain and placed in command of the Engine Division, Aviation Technical Section, AEF.

After two years overseas, he served successively as assistant chief engineer for Liberty Motor Car Corp. and then for Hupmobile Motor Corp.; as assistant to the vice-president in charge of engineering at General Motors Corp.; and as supervisor of engineering for all wheeled vehicles produced by Chevrolet during World War II. He joined Ford in 1947 as chief engineer.

1953 Chairman of the SAE Technical Board

E. S. MacPherson



D. B. Barnard

G. E. Burks

C. A. Chayne

H. E. Churchill

E. G. Haven

C. E. Mines

B. G. VanZee

Wachs New Head Of Committee S-2

Miller A. Wachs (left) of Sikorsky is the new chairman of SAE Helicopter Committee S-2. At right is J. P. Perry of Eastern Rotorcraft Corp., who has resigned

MILLER A. Wachs of Sikorsky is the new chairman of the SAE Helicopter Committee S-2. He takes over the job from J. P. Perry of Eastern Rotorcraft Corp., who recently resigned as chairman.

At its last meeting the committee decided to start a new project on nomenclature standards. Recommendations will be limited to terms unique to helicopter requirements and no consideration will be given to broad, general terms, which are defined in other nomenclature documents or to terms that have meanings that are recognized by general usage. Francis G. Weber, Kaman Aircraft Corp., is chairman of this subcommittee.

The committee also commissioned SAE Aircraft Air Conditioning Committee A-9 to develop a recommended practice covering air conditioning requirements for helicopters. As reported in the SAE Journal, January, 1953, p. 97, S-2 will appoint several helicopter men to do the job.

Bigger and Better Spring Manual Coming

THE manual on the "Design and Application of Helical and Spiral Springs," originally compiled at the request of the Ordnance Department, is now being completely revised by the SAE Spring Committee, under the chairmanship of Tore Franzen. The new edition will put the empnasis on industry and commercial design rather than on military usage, as in the earlier versions.

There will be new sections giving fundamental considerations of natural frequency, residual and trapped stresses, and fatigue durability. The section, "Fundamental Considerations of Energy," will be greatly revised and enlarged. It will show the capacity of various types of springs.

The section on materials will cover:

1. Resumé of the manufacturing practices involved in the production of the most common types.

2. Tables of materials with pertinent data such as now available in the Associated Spring Manual. Numerous changes and additions are contemplated.

There will be separate sections on compression, extension, torsion, flat spiral, and hot-wound springs.

A new section on surface protection, covering platings, patented coatings, pitfalls, and so forth, will also be included.

NEWS of SAE

Continued from Page 101

contacts with personnel of other companies for future exchange of ideas.

• And one man saw no particular advantage in attending the one panel that he sat in on.

Although the contacts made came out as an important part of the take-home pay from attending the Forum, the information dished up at the 11 panels proved very helpful. The ideas exchanged were useful and informative, said 88% of the men surveyed. In fact, 25 men said they came away with considerable help on specific problems at their plants.

These and similar comments showed that SAE's informal discussion format for meetings provides a real service to production men in the aircraft industry on the West Coast. General Chairman B. A. Willsey and his group, now planning the 1953 Aircraft Production Forum, also received sound suggestions on ways to improve the meeting.

They said it in different ways, but most of the survey respondents had one basic comment: We want more time for these panel discussions and more space too. One day just isn't enough. Chairman Willsey and his group are doing something about this. In 1953, the Production Forum at Los Angeles will run two days instead of one.

Useful suggestions also were received on how to operate the panels, subjects to be considered, promotion of the Forum.

Most of the comments were fairly extensive. They showed considerable thought and interest. The spirit with which the respondents replied to the query is pretty well summed up by the remark of one man, who said: "Thank you for the privilege of attending the Forum and for the opportunity to make these comments."

LARGEST . . .

. . . number of membership applications received.

IN December, 1952, more people applied for membership in SAE than in any previous December in SAE history, reports Membership Chairman J. H. Booth.

And what's more, he says, the 2491 applications for membership received in 1952 topped the totals of any previous calendar year.

SAE Section Meetings

February

Buffalo—Feb. 17

Hotel Sheraton, Buffalo. Dinner 6:30 p.m., meeting 8:00 p.m. Cummins High-Speed Diesel Engine—Cummins Engine Co. Film, "High-Speed Diesel Performance at the 500 Mile Indianapolis Speedway."

Canadian—Feb. 18

Roof Garden, Royal York Hotel, Toronto. Dinner 7:00 p.m., meeting 8:00 p.m. Speaker to be announced.

Central Illinois—Feb. 23

Jefferson Hotel, Peoria. Dinner 6:45 p.m., meeting 8:00 p.m. Automobile Styling—H. T. Bannister, DeSoto Studio, Chrysler Corp.

Cleveland—Feb. 9

Tudor Arms Hotel. Dinner 6:30 p.m., meeting 7:30 p.m. Talk on Truck Development—Paul Gillan, chief engineer, White Motor Co. Robert Cass, 1953 SAE President, will be speaker's sponsor.

Colorado—Feb. 19

Petroleum Club. Dinner 6:30 p.m., meeting 8:00 p.m. A field trip through Coleman Truck Co.

Detroit—Feb. 16

Ford Motor Co. Meeting 2:30 p.m., dinner 6:30 p.m. Sports Cars—Present, Past, and Future—James K. Gaylord and Norman E. Carlson. Introduction—E. S. MacPherson. Toastmaster—C. A. Chayne. Museum tour. Movies.

Metropolitan—Feb. 20 and March 5

Feb. 20—Kohler's Swiss Chalet, Rochelle Park. Dinner 6:00 p.m., meeting 7:30 p.m. Research Flight to Upper Atmosphere and Space—Milton Rosen. Cocktail hour before dinner. Dinner: $2.80 including tip.

March 5—The Brass Rail Restaurant, New York. Dinner 6:30 p.m., meeting 7:45 p.m. Symposium on Jet Air Transport Development—Norman Smith.

Mid-Michigan—March 2

Owosso City Club. Dinner 6:30 p.m., meeting 7:30 p.m. 12-volt Electrical Systems—A. L. Hartzell, Delco-Remy Division, GMC. 1953 SAE President Robert Cass.

This is not a complete list of all Section Meetings. It includes only those meetings for which we have received sufficient advance notice to permit listing.

Milwaukee—Feb. 13, Feb. 20, and Feb. 27

Feb. 13—Marquette University, Science Bldg., Room S-100, 1217 Wisconsin Ave. Meeting 7:30 p.m. A lecture meeting. Thermodynamics of Engines—P. S. Myers.

Feb. 20—Marquette University. Meeting 7:30 p.m. Lecture meeting. Combustion Chamber and Cylinder Design—H. M. Wiles, Waukesha Motor Co.

Feb. 27—Marquette University. Meeting 7:30 p.m. Lecture meeting. Piston and Piston Ring Design—W. P. Holcombe and H. M. Bramberry, Thompson Products, Inc.

Mohawk-Hudson—March 3

Circle Inn, Latham, N. Y. Dinner 6:45 p.m., meeting 8:00 p.m. Engineering Aspects of the 1952 500 Mile Race—Robert T. Jackson, Perfect Circle Corp.

Montreal—Feb. 16

Mount Royal Hotel. Dinner 6:15 p.m., meeting 8:00 p.m. Rolling Wheels Gather No Skids—A. C. Gunsaulus, Wheel and Brake Development, Goodyear Aircraft Corp.

Philadelphia—Feb. 11

Engineers' Club of Philadelphia. Dinner 6:30 p.m., meeting 8:00 p.m. The Growth and Status of Highway Transport—B. B. Bachman, Autocar Co. Technical Chairman: F. W. Kateley, ACF-Brill Motors Co.

Pittsburgh—Feb. 24

Webster Hall, Mellon Institute. Dinner 6:30 p.m., meeting 8:00 p.m. Engineering Frontiers—1953 SAE President Robert Cass.

Southern New England—March 4

Hartford Golf Club. Dinner 6:45 p.m., meeting 8:00 p.m. Military Vehicles—W. O. Miller. 1953 SAE President Robert Cass will be a guest.

Spokane-Intermountain—Feb. 20

Dinner 7:00 p.m., meeting 8:00 p.m. Report an Governor's Safety Council Meeting—George Shields, automotive supervisor, Pacific Telephone and Telegraph. Clarence Bear, maintenance superintendent, Hudson-Duncan and Co.

Syracuse—March 2

Joint meeting with Technical Club. A demonstration of Gyroscopes. The Tops—C. E. Jones, Physics Lecturer.

Twin-City—Feb. 11

Curtin Hotel, Minneapolis. Dinner 6:30 p.m., meeting 8:00 p.m. Fire Power. Ethyl Corp. Ladies Night.

Washington—Feb. 17

Burlington Hotel. Dinner 7:00 p.m., meeting 8:15 p.m. Aircraft Jet Engine Developments—Addison Rothrock, assistant director, National Advisory Committee for Aeronautics.

Western Michigan—Feb. 17

Bill Stern's Steak House. Dinner 6:30 p.m., meeting 8:00 p.m. Robert Cass, 1953 SAE President, will speak on Engineering Frontiers.

Williamsport—Feb. 25

Location not determined. Dinner 6:45 p.m., meeting 8:00 p.m. The Ignitron Rectifier Locomotive—E. W. Amos, Westinghouse Electric Co. Visit of 1953 SAE President Robert Cass.

SAE Section Meetings

Ethyl Corp. Engineers Investigate C-C Deposition

• Pittsburgh Section

A. E. Slagle and R. L. Sailer, Field Editors

Nov. 25—**H. J. Gibson,** director of engineering research for Ethyl Corp., presented a paper which he prepared with **C. A. Hall** and **D. A. Hirschler,** also of Ethyl, on combustion chamber deposition and knock.

The paper discussed a number of factors involved in the problem of octane number requirement increase due to combustion-chamber deposits. A laboratory single-cylinder engine test procedure, which evaluates the effects of various fuel and oil factors, was presented with data showing its correlation with passenger-car operation under light-duty, city-driving conditions.

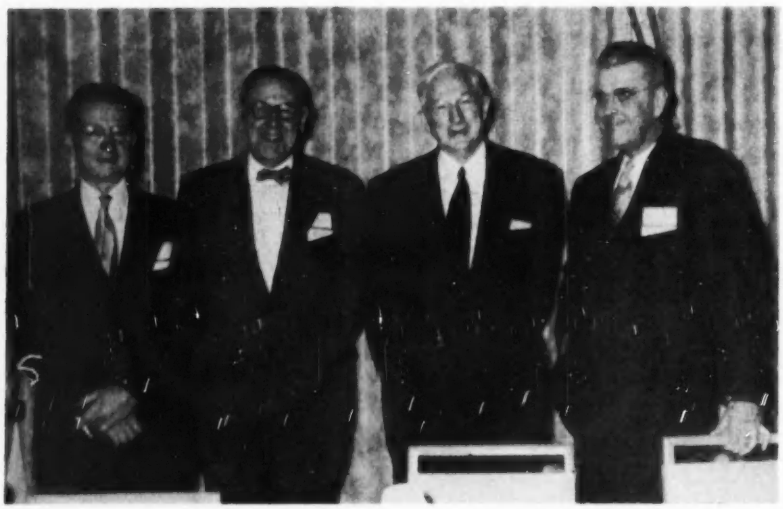
The influence of engine operating conditions during accumulation of deposits, and the importance of engine conditions selected to evaluate the magnitude of the requirement increase were emphasized. Organic materials formed from both fuel and oil are of major importance in deposit formation. The paper presented data showing that tel added to pure hydrocarbons of different chemical types may have different effects. It was shown that the carbon-hydrocarbon ratio of leaded pure hydrocarbons influences the amount and composition of the deposit formed.

Among leaded commercial gasolines there appears to be little effect of changes in hydrocarbon composition, although there is a trend toward smaller requirement increase as fuel endpoint is reduced. Similarly, removal of heavy ends from lubricating oils tends to lessen requirement increase, and the magnitude of this effect is dependent on the contribution of the fuel to the organic portion of the deposit.

Maximum effects are observed when clean-burning leaded isooctane is used as the fuel. Combustion-chamber design and deposit location influence the magnitude of the requirement increase.

The paper was of special interest to fleet operators and oil men, and J. Edward Taylor of Gulf, technical chairman of the meeting, conducted a lengthy discussion following the paper.

A highlight of the dinner which preceded the technical session was the presentation of certificates to four long-time members, all of whom are founder-members of Pittsburgh Section. R. J. S. Pigott of Gulf Research and Development, past-president and councilor, has been a member since 1918. Murray Fahnestock, editor of Ford Field magazine, who joined in 1921, has served as chairman of the Section and councilor. A. R. Platt, also a past-chairman of the Section, became a member of SAE in 1928. C. R. Noll of Gulf joined in 1930 and was Section chairman in 1932–33.



SAE past-president R. J. S. Pigott was among four who helped found Pittsburgh Section to receive long-time membership certificates at the Nov. 25 meeting. Pigott got a 35-year certificate; others received 25-year awards. Left to right: A. R. Platt, R. J. S. Pigott, Murray Fahnestock, and Charles R. Noll

Electronic Trainers Simulate Flight Accidents

• Northern California Section

J. A. Miller, Field Editor

Dec. 17—"Aviation Flight Safety" was the topic discussed by **C. M. Christenson,** director of safety, United Air Lines, Inc., a national authority in this field. Christenson's flying experience dates back to the time when the pilot flew "by the seat of his pants." He joined United as a pilot in 1935 after serving with the Army Air Force, and after 12 years became director of safety, the position he now holds. His contacts with the Bureau of Safety Investigation (CAB), the military, and his own experience have made him one of the foremost students of improved cockpit design, standardization of con-

trols and instruments and the reduction of crew fatigue.

Christenson described in detail the vast amount of effort, organization and engineering involved in promoting safety in modern air line operation. Throughout the discussion it was emphasized that in-flight safety depends, not only on well-trained, safety-conscious flight crews, but on safety in every branch of an air transport organization.

In discussing mechanical aids to flight safety, Christenson said that air lines are unique in safety training in that, through the use of electronic flight trainers (costing about one-half million dollars each), pilots are able to experience all the mishaps possible in flight and yet live to analyze the accidents and develop means of preventing them in actual service. Although mechanical safety devices and aids have reached a high point of development, Christenson pointed out that there is no known substitute for a well-trained, safe flight crew.

The meeting adjourned after a lively floor discussion of instrument landing facilities.

Richard A. Young was technical chairman for the meeting.

Three 35-year certificates and eighteen 25-year certificates were presented to Washington Section members by Dr. D. P. Barnard at the December meeting. SAE members for 35 or more years are (left to right) Harold W. Evans, Grover Loening, and Alex Taub

Barnard Presents Washington Certificates

• Washington Section

Allen P. Blade, Field Editor

Dec. 16—SAE President **D. P. Barnard** was guest speaker for the evening on the subject "Research—A Partner in Engineering". Dr. Barnard also presented certificates of SAE's recognition to three local 35-year members and to eighteen 25-year members. John C. Hollis, of the SAE staff, New York City, accompanied Dr. Barnard; among other honored guests was Dr. Floyd Miller, vice-chairman, Research and Development Board, Department of Defense. Chairman Jack Hulse presented a certificate of appreciation to immediate past-chairman Bert Ansell on behalf of the Section.

Dr. Barnard used many slides and anecdotes from his distinguished experiences to fortify his thesis that research is engineering's partner. Dramatic instances are involved in the ever-increasing effort to develop better petroleum manufacturing methods and in showing how various sciences have been called upon for more effective means of locating oil sources.

Highly instrumentalized methods used today include the gravimeter, seismic soundings, the magnetometer, electric logging and strata coring devices. Exploration methods used over the years have kept proven resources of petroleum ahead of demands; at the present time such resources are estimated at 26 billion barrels, amounting to a 12-year reserve. Improved methods of refining and exploration can be expected to keep petroleum resources ahead of demand for many years.

Advances in the petroleum industry have made an adequate supply of liquid fuels of increasingly higher quality available to the continually expanding automotive industry. The advances in both of these industries have been accomplished, to a very large degree, through the research work of the trained engineers.

Progress has been made by the refining industry in increasing both the yield from crude and the quality of gasoline. Yield has increased from about 20% of crude to the present day average of 60%. The octane quality has been improved from about 50 to present-day levels of 84. The processes used to bring about these improvements, thermal and catalytic cracking, polymerization, alkylization, isomerization, and so forth, were concisely illustrated.

The refinery gate price for motor gasoline excluding taxes is about thirteen cents per gallon. Gasoline from alternate sources cannot, at present, compete in manufacturing cost with gasoline refined from crude oil. Refining technologists estimate that gasoline manufactured from shale oil would cost about 14 cents per gallon; from other sources the estimates are higher. Also, alternate sources of liquid fuels require considerably greater quantities of steel and greater capital expenditures than are required for refining crude petroleum.

Dr. Barnard concluded his talk with a reminder that there is a demand for an increasing number of trained research workers. A dominant factor in the future progress of the automobile and the petroleum industries is the number of technologists engaged in research and development work. Recognizing that there is today a shortage of such workers and a greater shortage predicted for the future, we should encourage the training of many "partners in engineering."

Maintenance Engineer Must Seek Trouble Sources

• Colorado Group

Robert F. Brown, Field Editor

Dec. 18—The job of the maintenance engineer was likened to that of the pathologist by **E. F. Lindsley.** It is not enough to cure the symptoms of engine trouble; the maintenance engineer must learn, by observation of past problems and mistakes, to cure trouble at the source.

Lindsley, a field service engineer for Waukesha Motor Co., showed that blind adherence to a general check list

is often little better than an indefinite maintenance schedule. A good maintenance schedule must be tailored to the needs of the special operating regime of each kind of equipment. "The 'pathologist of pistons,'" Lindsley said, "must use his engineering techniques combined with imagination and powers of observation and deduction to build up a suitable check list and schedule."

The speaker was introduced by Del Davis, district manager of Waukesha Engine and Equipment Co.; the company was host to the meeting at its new Denver plant facilities.

Heavy Duty Oils, Cam Design Discussed

• Central Illinois Section

R. B. Applegate, Field Editor

Dec. 15—The December meeting was the annual "Members' Meeting," at which members of the Central Illinois Section present papers. This year, papers were read by **J. W. Vollentine** and **Alexander Goloff**, both of whom are staff engineers in the Research Department of Caterpillar Tractor Co.

Heavy Duty Lubricating Oils

Vollentine's paper discussed the history and the development of the present day heavy duty oils for diesel engines.

In the early 1930's, when high speed diesel engines began to appear on the market, the oils available were practically all of the non-additive type. It soon became evident that straight mineral oils were not adequate for the heavy duty engine. Additive type oils first appeared in 1936 and were the result of a cooperative test program between Caterpillar Tractor Co. and several oil companies. This program determined that the addition of specific additive agents could improve the performance of crankcase oils, and that a lubricant must be developed on actual engine tests rather than on laboratory analyses. As a result, Caterpillar has developed and built a single cylinder diesel test engine for evaluating lubricating oil performance.

Oil additives perform a number of useful functions—as detergents, oxidation inhibitors, V. I. improvers, oiliness agents, pour depressants, dye, and anti-foam agents, among others.

At the end of World War II, it was found that certain engines were giving performance far below that expected. As the result of another test program, it was found that sulfur in the fuel was the most important contributing factor to these engine failures. After a period of time, a new series of oils was developed containing higher additive levels and additive types to combat the effects of the sulfur. These new oils were designated by Caterpillar as Superior Lubricants (Series 2) for Caterpillar engines.

The first additive oils developed were designated by the U. S. Army as U. S. Army Specification 2104-B, and a later oil of somewhat higher quality giving improved performance of military equipment was designated U. S. Military Specification Mil-0-2104.

The two principal tests of the 2104-B oils were the L-1 test on a Caterpillar single cylinder oil test engine and the L-4 test run on a Chevrolet automobile engine. The complete names of the tests are, respectively, "CRC Designation L-1-545" and "CRC Designation L-4-545."

In establishing the approval of an oil according to the military specification, the L-1 test is run by the oil company or an independent test laboratory and the result submitted to the Ordnance Engine Oil Reviewing Committee. Series 2 oils are evaluated according to the Test 1D procedure established by Caterpillar Tractor Co., this program not being connected with the military. The additive content required for Series 2 oils is approximately 4 to 5 times that of Mil-0-2104 oils.

Vollentine's talk was accompanied by slides.

Good Cam Design

Alexander Goloff, in his paper, "General Considerations in Cam Design," discussed briefly the factors which make a good cam.

Among the more important factors are proper timing, snappy action, quiet operation, long life of all valve components, and ease of fabrication. Proper timing means that the cam duration must be correct. The general shape of the lift curve, as well as the way in which the valve takes off and seats, affect the effective duration of the profile.

The valve action should be as snappy as possible without hurting the life of the valve or valve seat. Noise due to the rapid taking up of valve lash is objectionable in automobile engines. Long life is concerned with low seat and face wear, no scuffing of cam or tappet, and minimum valve spring surge. Ease of fabrication is, of course, an essential factor. The best cam design is of no use if it cannot be machined.

Maximum velocities should be as great as possible for snappy action; however, the acceleration curve should be smooth. Also valve train vibration should be kept as low as possible. Spherically-faced followers and barrel-shaped follower bodies help in reducing the evils of misalignment of the cam and its follower and therefore permit greater deceleration values.

Because of valve train deflections at high speeds, there has developed a trend to try to compensate for dynamic deflections. The method normally used is called the polydyne method, in which the desirable shape of the acceleration and lift curves is specified at the valve and not at the cam. Under these conditions, the specified acceleration curve at the cam is relatively involved and even discontinuous at its end. Some results of this type design indicate improvements in valve motion, the compensation is not consistently satisfactory.

It is most important to know what a given engine actually requires. To do a good job, one should examine all the components of the valve train. Previous valve motion studies should be examined and engine performance

The Dec. 15 meeting of Central Illinois Section featured two talks by Section members. Left to right: Technical Chairman R. S. Mills; J. W. Vollentine, who spoke on heavy duty lubricants; Alexander Goloff, who outlined requirements for good cam design; Coffee Speaker J. W. Page; and Section Chairman J. T. Liggett. All are of Caterpillar Tractor Co.

records evaluated. On the basis of past experience, good judgment, and latest thinking, the camshaft designer stands a much better chance of obtaining superior results. Copying other successful cam profiles is not necessarily a profitable undertaking.

Goloff also accompanied his talk with slides.

The coffee speaker was J. W. Page, research staff engineer at Caterpillar, and the technical chairman was R. S. Mills, staff engineer in the Engineering Department at Caterpillar.

Three members of Mohawk-Hudson Group received certificates of their long membership in SAE at the Dec. 9 meeting. Chairman John J. Broderick (left) presented the framed certificates to C. W. Kelsey, president of Rototiller, Inc.; Donald K. Wilson of Niagara-Mohawk Power Corp.; and Charles H. Crockett of Chicago Wheel and Mfg. Co.

High Standards For B-47 Pilots

• Wichita Section

Jay H. Whoolery, Field Editor

Dec. 10—Pilot training in the Boeing B-47 and ejection seats for fighter aircraft were discussed by **Maj. W. C. Herrington**, assistant group training and operations officer for B-47s at Wichita Air Force Base.

Major Herrington called attention to the fact that a great amount of experience is required before a pilot is considered for B-47 flight experience. The job is very complicated, requiring knowledge as a navigator, bombardier and radar observer, as well as the qualities of an exceptionally good pilot. This covers about a sixteen-week course in Wichita. Most of this time is spent in training on the two-place T-33 aircraft, partly for reasons of economy.

As can be seen from the four titles, the pilot is required to have had over 2,000 flying hours and be outstanding in every respect, and highly recommended by his base commander. In actual war operation it is doubtful if the pilot would quite meet the present standards.

Major Herrington gave a running report during a film showing the operation of the pilot ejection seat. The pilot feels he is in the electric chair when first sitting down in this seat, Herrington commented. Later, though, he becomes more comfortable and feels it is quite a safety device.

Due to the great speed of jet aircraft, the pilot does not have the strength to climb free when the plane is disabled. There are tons of weight against him as he tries to leave the cockpit. He is pinned in that position. Even if he could free himself from the aircraft, he would more than likely be trapped in the tail surfaces. The ejection seat throws him well clear of the aircraft. The force of the seat statically will propel a man to a height of about three stories. Immediately after leaving the cockpit, the pilot must completely part himself from the seat so that it will not fall and tangle with the safety chute on its way down.

The Major's final comment was that those pilots who have had occasion to use the ejection seat are very much in favor of it . . . and comments are not available from the pilots who did not use the ejection seat!

"Old Timers" Receive Certificates

• Mohawk-Hudson Group

Knud Antonsen, Field Editor

Dec. 9—To provide a suitable occasion for presentation of "Old Timers' Certificates," the December meeting of the Mohawk-Hudson Group was arranged as a social evening. After the showing of two films: "Clean Water" and "Sightseeing at Home," both by the General Electric Co., John J. Broderick, chairman of the group, presented the certificates.

Two 35-year certificates and one 25-year one were presented. C. W. Kelsey, president of Rototiller, Inc., who joined SAE in 1916, and Charles H. Crockett, sales engineer for Chicago Wheel and Mfg. Co., who joined in 1917, received 35-year awards, and Donald K. Wilson, superintendent of automotive equipment for Niagara-Mohawk Power Corp., received the 25-year award.

After presentation of the framed certificates, an orchestra provided music for dancing and a late buffet supper was served.

Discuss Growing Use Of Multipurpose Grease

• Southern California Section

P. Kyropoulos, Field Editor

Dec. 11—**Dr. Earl Amott** presented the paper on "Multipurpose Grease—the Growing Trend in Lubrication" which he and **L. W. McLennan** of Union Oil Co. presented at the West Coast Meeting last August.

The paper consisted of a review of the development and early use of multipurpose greases, compared the volume of such greases now in use with the corresponding volume of conventional grease, and discussed the advantages and disadvantages associated with each type of grease.

It further discussed future trends toward multipurpose greases, together with several recent developments in the lubricating grease field; and considered the use of gear oils rather than greases for the lubrication of truck wheel bearings, and centralized lubrication systems for chassis lubrication of cars and trucks.

Dr. Amott is a group leader in the lubricating grease section, and McLen-

Continued on Page 116

Petroleum Supply Adequate, Barnard States

• Indiana Section

V. H. Lewis, Field Editor

Dec. 11—Our perpetual 12-year oil supply was elaborated upon by SAE President **D. P. Barnard** in his address on "Research in the Oil Industry" at a dinner meeting of the Indiana Section. He outlined the oil industry activities in the form of two problems: to find enough oil for our needs,—and to make the things that we want from the available oil.

In the discussion of sources of crude it was noted that although the U. S. consumption has increased from one million to over six million barrels per day, the known reserves still remain substantial. This fact was illustrated by means of a graph which indicated that new supplies of oil are being discovered at almost the same increasing rate as consumption. The existing reserve today stands at about 26 billion barrels.

Research is responsible for increasing and improving the methods of finding oil supplies. However, to date there has been no fool-proof device developed. Low density structure, which is common with the presence of oil, is detected by the measurement of small differences of gravitational pull. Sampling of upper strata by core drilling is used as an indication of type of structure at deep levels in many places. Seismographic equipment also is used for depths of 5000 to 6000 feet.

In regard to alternate sources of liquid fuel, Dr. Barnard stated that while the shop cost of gasoline made from crude is 13 cents per gallon it jumps to 45 cents per gallon when made from coal. The fact that coal is a poor source of oil is the reason that the oil industry is directing its main efforts toward finding new supplies of crude.

Higher Yield from Crude

Turning to the processing of the crude oil, Barnard pointed out that the production of gasoline from crude has increased from 18% in 1906 to about 65% today. Fractional distillation, thermal cracking, and catalytic cracking are steps resulting from research and development that have helped to refine the processes to today's level. The speaker illustrated this tremendous progress with slides showing both early equipment and modern plants.

During the discussion period that followed the presentation Dr. Barnard answered the question of Russia's known oil reserves with figures of approximately one million barrels per day (less than one-sixth of U. S. production), including all Russian satellites.

The social half-hour, a regular Indiana Section function, was sponsored by Standard Oil of Indiana, and was attended by many SAE friends of Dr. Barnard.

At the social hour preceding his address Dec. 11, Dr. D. P. Barnard chatted with members of Indiana Section. Left to right are Past-Chairman William Powell, Dr. Barnard, Past-Chairman H. L. Elfner, August Duesenberg, and present Chairman R. P. Atkinson

Winding up his term as 1952 president of SAE, Dr. D. P. Barnard visited Baltimore, Washington, Virginia, Dayton, Cincinnati and Indiana Sections and Atlanta Group during December. At left, he inspects the automotive research laboratory of Pan American Refining Corp. during his Dec. 16 visit to Baltimore. At right, he presents a 25-year certificate to Ray D. Lewis at the Dec. 9 meeting of Cincinnati Section

SAE Student News

College of the City of New York

The Student Branch at CCNY was fortunate in having as speaker at its Nov. 13 meeting **Francis W. Davis**, consulting engineer, who spoke on "History, Development and Application of Power Steering" and "Patent Procedures."

Davis has been very active in the development of power steering components; he is the inventor of the "Davis Hydraulic Power Steering Gear", currently manufactured by Bendix Products Division of General Motors Corp. and the Ross Gear and Tool Co. He also invented the "Davis Hydraulic Pump" and owns over 30 U. S. and foreign patents.

Davis presented a brief history of the evolution of the steering gear along with slides illustrating various power steering systems and how they operate. In Davis' opinion, the current controversy over spring-loaded manual threshold units versus non-spring-loaded units will eventually be resolved by public acceptance.

Davis also spoke of the problems confronting the independent inventor. He gave many helpful tips on the preparations necessary to obtain a patent on an invention and meeting the subsequent difficulties which may arise. He then discussed the methods of obtaining a return on the invention.

—**Mario D'Onofrio**

Chrysler Institute of Engineering

Stock car racing was the topic at the Nov. 20 meeting. Two speakers and movies of stock car racing were featured. Speakers were **Bob Sampson** of the Chrysler Corp. dynamometer research department, and **Ed Jones**, president of the Michigan Modified Stock Car Racing Association. The films traced the progress of stock car racing from the old cow pasture days to the present.

The most surprising thing was the low number of serious injuries despite the many and freakish accidents, especially among the hard-tops. This fact is probably attributable to the safety devices used and to the efficiency of the track officials in removing wrecks and injured drivers from the track and in handling other such emergencies.

One of the highlights was the showing of a destruction race. This type of race is a no-holds-barred affair in which the last car running is declared the winner. The race shown was won by Bob Sampson in a '37 Pontiac. Another highlight was the wrecking of car 454. The car rolled over several times and was almost completely demolished. Ed Jones commented that the car had been built by a welder and driven by a bartender, and the only weld that had not broken was the one that the bartender himself had done.

The speakers pointed out that stock car racing is still practically an amateur sport; the most successful drivers are lucky to break even.

—**Gene Cowie**, Field Editor

Detroit Institute of Technology

Twenty members of the SAE Student Branch at DIT toured the Detroit laboratories of Ethyl Corp. on Nov. 11. They were welcomed by Dan M. Guy, Joseph Cipolla and other company engineers, who explained the test work currently under way at the laboratories. The students gained first-hand information on some of the combustion problems of gas and diesel engines, and how Ethyl products are used to solve them.

At a luncheon on Oct. 22, Neff Dietrich, sales engineer for Midland Steel Products Co., spoke on "Product plus Personality in Sales Engineering." Foster Cunningham, Student Branch chairman, presided.

—**Harry Pelton**

The Pennsylvania State College

On Dec. 11 the Student Branch heard a talk by **Professor W. E. Meyer** of the Department of Engineering Research at Penn State on "Fuel Injection Engines."

He passed over diesels lightly and then took up the application of injection in aircraft and in European spark ignition engines. Shortly before the end of World War II, plans had been made to convert many B-29 bombers to fuel injection to increase their range for Pacific Theater operation, Meyer said. He also told how the CAA had required fuel-injection systems installed for additional safety on all Constellations after the war when they were having so many crack-ups.

He then discussed German applications of injection, with special emphasis on a post-war auto engine now produced there. This engine, by utilizing fuel injection, compounded the advantages of the system with the removal of carburetion difficulties to produce a spectacular improvement in performance for the engine used.

The advantages of the injection system in spark ignition engines that he mentioned were: better and safer fuel distribution, better air distribution, simpler manifolding, increased volumetric efficiency, easier starting, and the wider range of fuels usable. It has the advantage over diesels of not requiring such expensive and precise injection equipment. A gain of 10% in either power or efficiency may be expected. The disadvantages given were the higher cost, relative to carburetion systems, and difficulties in fuel-air ratio controls.

The program was concluded with a showing of a movie of the actual firing of the fuel in a fuel injection engine.

Dr. P. H. Schweitzer of the department of engineering research at Penn State spoke on "New Developments in Diesel Engines" at the Nov. 19 meeting of the SAE Student Branch.

Slides of some of the newest diesels were shown including the new "high-economy" Krauss-Maffie bus engine recently developed in Germany and the large gas burning diesels now being used in Texas power plants to generate electricity. It was pointed out that since the diesel is inherently more efficient than a steam turbine, it can produce power less expensively on gas than could a gas fired steam powerplant.

After the lecture detailed pictures of many new diesels were exhibited.

—**Joseph K. Thornton**, Field Editor

nan supervises research activities on a number of products, including lubricating oil greases, for the Union Oil Co.'s Research Division at Brea, Calif.

After the presentation of the paper on multipurpose greases, R. W. Mertes, research chemist, Union Oil Co., presented a discussion of the new A.P.I. designations for motor oils. This was a very timely subject and proved extremely interesting.

Receiving 25-year certificates at the December meeting of Twin City Section are (left to right) B. J. Robertson, Section chairman, of Minneapolis-Honeywell Regulator Co.; Fred W. Anderson, president of Northwestern Motors Co.; Paul Shivers of Minneapolis-Honeywell; and Tom C. Hendrickson of Pure Oil Co. Another 25-year member, Ralph H. Upson of the University of Minnesota's department of aeronautical engineering, was unable to be present

Automation Offers Lower Production Costs

• Twin City Section

D. D. Hornbeck, Field Editor

Jan. 14—"Greater production per machine can be established by eliminating the inherent delay in loading and unloading cycles," according to **John McDougall**, Ford Motor Co. engineer. In expanding his topic, "Automation at Ford," McDougall indicated that with "Automation," machines and equipment are virtually run at full speed 100% of the time, except for time required by normal maintenance and tool changes.

Automation (automatic handling) offers lower production costs by reducing the manual handling of parts and the human error factor. Whereas human labor is subject to psychological and fatigue patterns which affect both quality and volume, automation can be effective in reducing fatigue of those employees who must remain by using simple interlocked electrical controls to make the decisions, and by employing mechanical devices to do the actual labor.

McDougall discussed the organization and functions of an Automation Department, pointing out through motion pictures the benefits to be gained by planning a plant with automation in mind. He drew a contrast between certain existing operations, such as cylinder block machining, piston machining, and engine assembly, and similar operations at Ford's new Cleveland Engine Plant.

Each of the points was covered in a general manner so that SAE members and guests were able to obtain an overall knowledge of the factors involved.

25-Year Certificates

More than 125 years of SAE membership were recognized at the December meeting of the Twin City Section when five members were awarded 25-year certificates. Each of the men is actively engaged in the continued pursuit of his life work in the field of engineering.

Those receiving certificates were B. J. Robertson, Section chairman and Minneapolis-Honeywell Regulator Co. engineer; Fred W. Anderson, president of Northwestern Motors Co.; Paul Shivers, Honeywell engineer; Tom C. Hendrickson, Pure Oil Co. engineer; and Ralph H. Upson, professor of aeronautical engineering, University of Minnesota. The Twin City Section wishes them a continued success in the engineering field.

Attendance at the monthly SAE meetings has been at an all-time record level this season, nearly double that of previous years, and averaging well over 90 members and guests per meeting. With the interesting series of meetings scheduled for the spring, it is hoped that this may be increased.

Hot Rods Topic Of San Diego Meeting

• San Diego Section

Paul L. Brady, Field Editor

Dec. 9—Methods of converting stock motors to high powered "Hot Rods" were discussed by **Fred Davies**, director of the National Hot Rod Association.

Davies presented a summary of the San Diego Timing Association activities and introduced specialists in their field of engine modification. He said that the San Diego Timing Association is primarily a safety organization, composed of 14 member clubs whose main interest is the participation and safe control of regularly scheduled drag races on the Paradise Mesa air strip, near National City, Calif. It was pointed out that all law enforcement and public safety officials heartily endorse the principles of the Association governing the youthful and not-so-youthful enthusiasts of the Hot Rod sport. The Association classifies all cars in competition according to their cubic inch displacement and body styling in addition to applying a rigorous safety inspection procedure prior to competition.

The history of hot rodding was ably presented by Fred Jordan, SDTA secretary. The development from the unorganized to the organized hot rod activity in the past 25 years was compared to the history of auto racing. Overcoming public criticism resulting from unorganized hot rod activities has approached crusade-like proportions.

John Cramer, a director of the SDTA, outlined the methods of modifying standard engine construction to obtain the desired results of increased horsepower or fuel economy. Design changes in camshafts, valves, ports and manifolds to improve engine "breathing" was described. It was noted that very few hot rodders incorporate superchargers in their engine build-up, due to limited funds available. Most conversions are the

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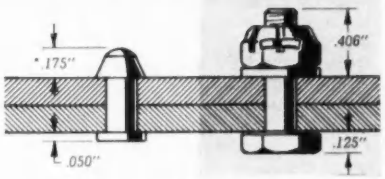

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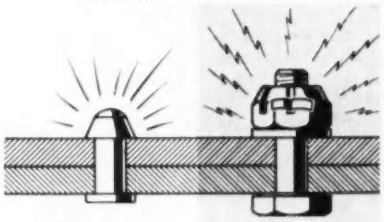

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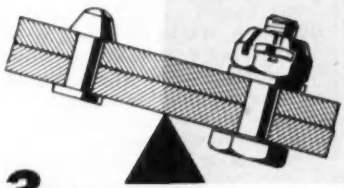

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result of group or club financial as well as physical assistance. These engine changes are evaluated by dynamometers, drag races, and measured mile speed trials. Davies' Nash Rambler, clocked at a speed of 111 mph, was available for the close inspection of the SAE members and guests. Cramer stated that incorporation of some hot rod tricks in the late model automobiles, such as dual exhaust systems and multi-carburetion, adds impetus to the development of new designs.

Roland Leischner, a special machinist, described methods used in balancing the reciprocating and rotating parts of engines. He stated that more than half the weight of standard flywheels was removed with no effect on engine performance.

J. Otto Crocker described his famous Crocker certified electronic clock. This piece of equipment, nationally known as one of the most accurate recording timers, is accurate to one-thousandth of a second. The recording mechanism will type results every one-tenth of a second.

Davies concluded the meeting by noting that accessory manufacture and engine conversion is now a multi-million dollar industry on the west coast. As an illustration he stated that stock V-8 engines may be modified from 100 hp to as high as 300 hp class in machine shops created primarily for this type of business. This conversion, aptly called a "Street Job," is suitable for use on the highways and practical with respect to service life.

A color film of the Bonneville Hot Rod racing operation in Utah concluded the meeting.

Designer Traces Trends in Styling

• Milwaukee Section

P. S. Myers, Field Editor

Dec. 5—**Brooks Stevens**, internationally known industrial designer, both entertained and informed a crowd of about 150 engineers with his talk on "American Motor Car Styling—Conventional and Sports," at the December meeting of the Milwaukee Section. Stevens has been instrumental in the design of the Hiawatha train, Kaiser-Frazer automobiles, Evinrude outboard engines, Briggs and Stratton engines, and numerous other industrial products.

Stevens emphasized that the industrial designer is usually concerned only with outside appearance and not with internal mechanisms, and that he plays a large part in creating new consumer desires.

Speaking specifically of motor car design, Stevens showed a futuristic car—1942 design—featuring a plastic

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bubble top with a three-wheel undergear and a rear engine. He traced the evolution of this futuristic body into a practical post-war body with a curved windshield and small pillar posts conveniently located.

He also discussed the comparative merits of front and rear engine location in regard to noise, heat, space, and so forth, and concluded that the front location is probably most advantageous.

Stevens then reviewed post-war style changes, pointing out the general emphasis on speed and streamlining effects, and the frequent adaptation of airplane characteristics and appearances to produce these impressions. Among the few exceptions mentioned were the Lincoln Continental and the Jeepster. The styling of the Willys line, adapted from the famous wartime Jeep, was discussed. It was pointed out that utility both in appearance and arrangement is emphasized.

Pictures showed the gradual evolution of the current Kaiser-Frazer design from a rather hastily-designed post-war model to the present attractive automobile. The styling evolution of the Henry J. was also presented.

A few pictures of past and present sport cars were shown, with emphasis being placed on the adapted Henry J. 100 hp, 1500 lb model, which is to be built by Kaiser-Frazer and is expected to sell for around $2000. This car will do one-quarter mile in 15 seconds from a standing start.

The question and answer period brought out the fact that the Kaiser sports car has a Fiberglas body but that, at present at least, it does not seem feasible to mass-produce this body. It was also mentioned that the weight was about the same as an aluminum body, but on high production might cost more than aluminum. Stevens felt that sports cars will increase in popularity but will probably not reach high production.

Questioning brought out that long hoods are considered indicative of high power; but Stevens wasn't quite sure why the present high horsepowers were being advocated and used. It was also mentioned that the Kaiser sports car uses a conventional gear shift with overdrive.

Ford Experts Analyze Distribution of Fuel Energy

• Metropolitan Section

Jan. 8—With only about 24% of the Btu's of gasoline going to useful work in the modern gasoline engine at 40 mph, operators of vehicles were warned to try to improve their drivers' driving habits.

Harold S. White, O. Enoch and E. L. Haynes, Ford Motor Co., presented a detailed analysis of where your gasoline Btu's go, pointing out that cooling and exhaust systems add up to twice as much energy as the engine power.

Although the American public is not now fuel-economy conscious, some emergency may change the public's disregard of cost of gasoline, they pointed out.

Higher compression ratios, improvements in engine breathing and reducing back pressures have, over the years, given the motorist and commercial vehicle operator increased mileage per gallon.

But at best, the modern engine gets only about 17% of useful work out of the gasoline Btu content.

At 40 mph, windage, tire rolling friction, rear axle and transmission losses account for about 7.6% of the Btu's, radiation takes 24.2%, cooling 22.9%, the exhaust 28.5% and friction 3.7%.

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fuel economy, whether good, bad or indifferent, starts when he pulls out his choke.

"A small amount of choke does not effect miles per gallon, but a large amount causes serious waste of fuel," the authors pointed out.

Only the minimum amount of choke should be used, and the choke should be released as soon as possible for best economy.

Approximately seven times the distance was needed to warm up an engine to normal fuel mileage of 20 mpg at 40 mph after a cold start than after a hot engine start, they found.

Fuel mileage during wide open throttle acceleration is worst in first gear, better in second and best in third or direct, and the mileage is not greatly affected by the speed at which the gears were shifted.

Drivers in the Grand Canyon economy runs tried to stay in third gear or direct during acceleration.

Traveling speed, of course, was reduced. This is the price that must be paid for superior economy.

Driving at 20 to 30 mph is not generally practical, although these speeds are more economical insofar as fuel is concerned. But reduction of speed from 60 to 50 mph can increase gasoline economy about 12%.

A steady driving speed, rather than high speeds, results in a good speed average, and a good driver can really save fuel if he keeps this fact in mind, the authors said.

Anticipating stops and using momentum of the vehicle to save fuel is another way to increase mpg.

"The jack rabbit driver converts the vehicle's kinetic energy into brake lining abrasion and tire wear," it was pointed out.

A dirty air cleaner can cause the loss of as much as 1½ mpg.

Restricted exhaust, such as is caused by a pinched tail pipe or obstructions in the muffler, shows a marked drop in fuel economy, it was shown.

Reduced tire pressure is expensive.

Oscar Wuerz, National Transportation Co., and Wilbur G. Perriguey, Esso Standard Oil Co., presented prepared discussions.

Chairman of the technical session was Robert M. Cokinda, Section vice-chairman for the Fuels and Lubricants Activity.

Says Carburetion Increasing in Complexity

• Williamsport Section

Paul Cervinsky, Field Editor

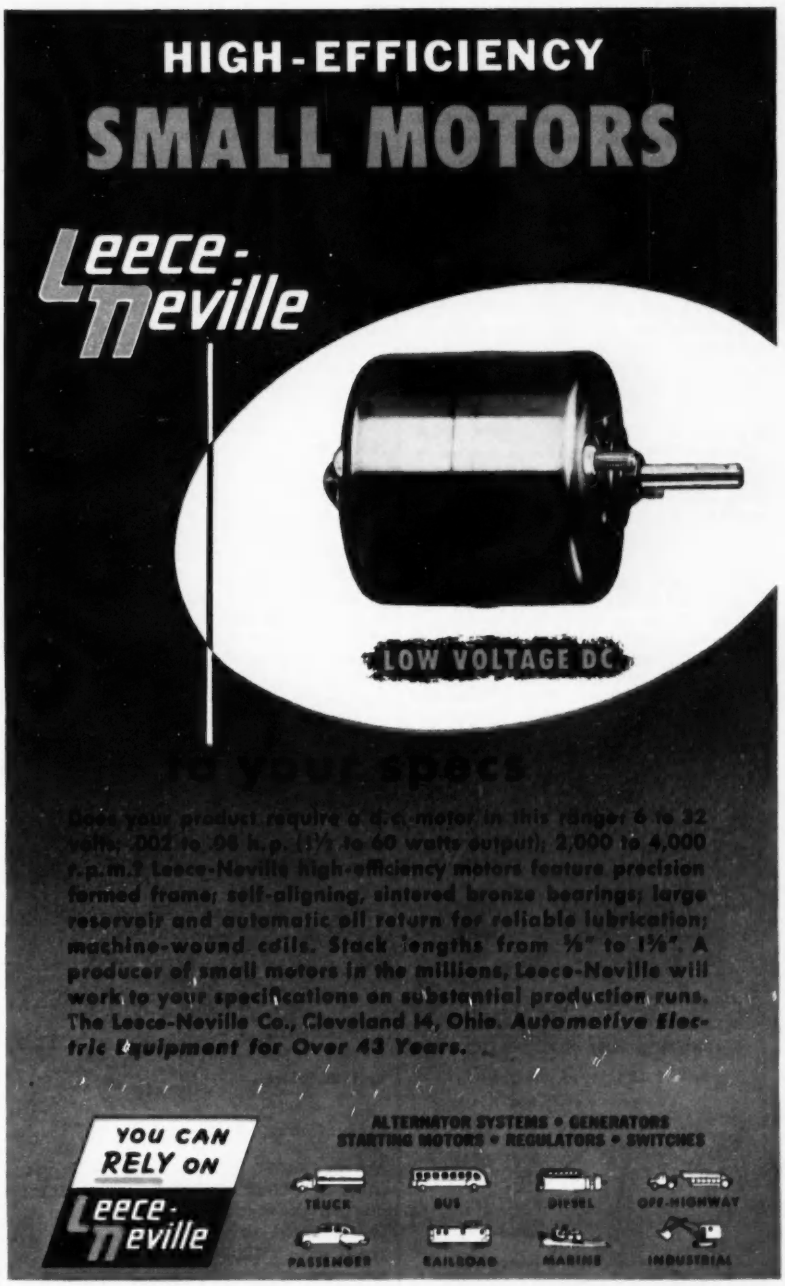
Jan. 5—Carburetion for today's automotive vehicles is becoming more complex, especially with the advent of the automatic transmissions, **A. H. Winkler**, chief engineer of automotive carburetors, Eclipse Machine Division of Bendix, told 55 members and guests of the Williamsport Group.

The successful operation of the carburetor depends upon the blending in of the various systems in the carburetor, said Winkler. But, he added, manifolding and carburetion must come hand in hand to make successful engine operation.

The early needle valve with the addition of the float system, main system, power system, idle system and acceleration system and other special systems make up a modern automotive carburetor.

Discussion brought out that:

1. Large production is necessary to keep down the cost per unit.
2. Carburetion itself is not always the culprit of malfunctioning engines.
3. Through all seasons and altitudes, better carburetion can mean large savings for the vehicle owner.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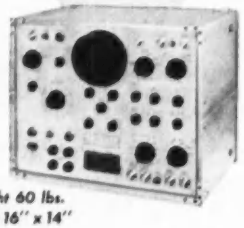

Weight 60 lbs.
13" x 16" x 14"

Another Waterman first, a compact, portable wide band pass laboratory oscilloscope with markers that are triggered in synchronism with the incoming signal. Ideal for pulse measurements, such as shape, amplitude, duration and time displacement. S-5-A LAB PULSESCOPE is adaptable to all kinds of electronic work where knowledge of circuit performance is essential. Built in Video delay permits observation of leading edge of triggering pulse. Precision means of amplitude calibration are provided. Sweep can be either repetitive or trigger with 10 to 1 expansion when desired. Internally generated markers, together with Video calibration, provide quantitative data of amplitude, shape, duration and time displacement of pulses. The oscilloscope thus is truly a PULSESCOPE, another Waterman first.

Video amplifier up to 11 mc . . . Video Delay 0.55 μs . . . Pulse rise and fall time better than 0.1 μs . . . Video sensitivity 0.1v p to p/in. . . . Sweep 1.2 μs to 120,000 μs with 10 to 1 sweep expansion . . . Sweep triggered or repetitive . . . Internal markers synchronized with sweep from 0.2 μs to 500 μs . . . Trigger generator with output available externally . . . Built in precision amplitude calibrator . . . Combination case . . . Operates on 50 to 1000 cycles at 115V AC.

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Technical Digests

Power Hydraulics Ready to Take Controls

Based on paper by

R. H. FRITZGES

Mack Manufacturing Corp.

WEIGHT and size reduction are the primary advantages justifying selection of hydraulic fluid as the working medium for automotive equipment. Other advantages are: incompressibility, which makes for positive and swift action, self-lubrication of equipment, and inherent protection from overloading.

Power hydraulics can be applied at a cost that is competitive or comparable to that of present pneumatic equipment. A bus can be equipped without any great changes in the manufacturing methods or techniques used on air systems. A weight saving of approximately 150 lb has been recorded, and this does not include the bonus of power steering which counts for about 90 lb more.

A relatively new field in hydraulic development is the hydraulic starter, which is being used experimentally on large diesel truck engines. The system, which uses a pump, accumulator, and reservoir, in addition to a hydraulic starting motor, could possibly be included on a truck or bus already equipped with a full pressure system and thus utilize a common pump, reservoir, and accumulator. Once a power source is established on any vehicle, all of the controlled devices could be powered by the common working medium. Effective use of hydraulic power will bring about operational ease, less maintenance and, above all, increased safety. (Paper, "Total Control with Power Hydraulics," was presented at SAE National Transportation Meeting, Pittsburgh, Oct. 23, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

Based on Discussion

By E. N. Hatch

Director of Franchises,
Nassau County, N. Y.

MANY states have a rear-axle load limit of 18,000 lb. Thus, with a large city bus having a rear engine, the designer must shift more weight to the front axle. This done, power steering becomes of paramount importance to

NEXT...

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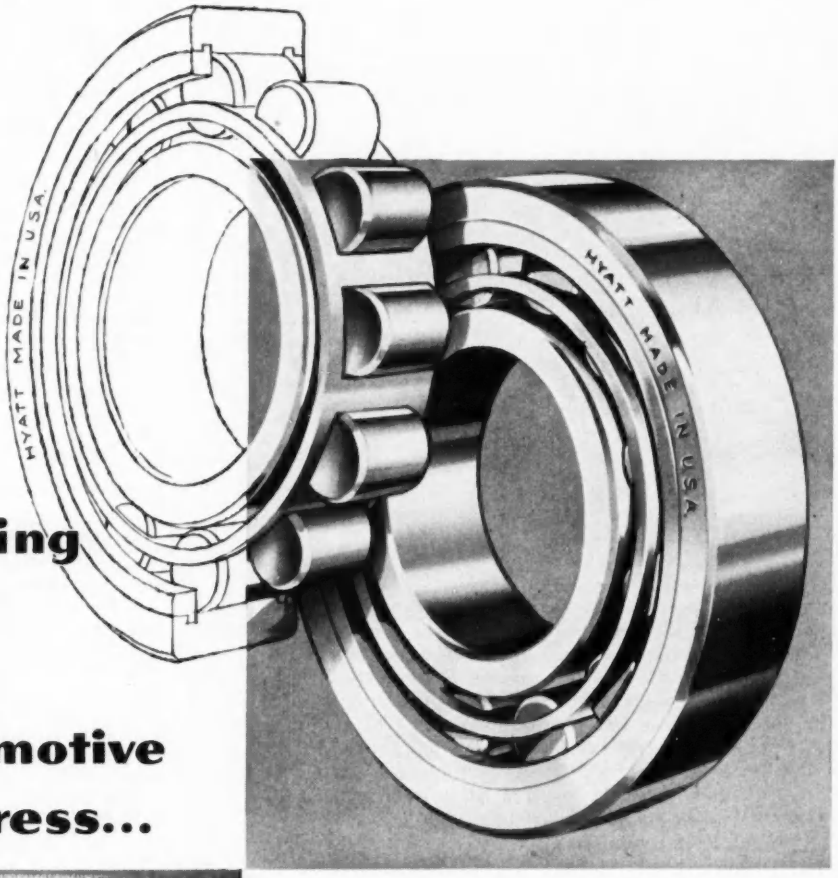
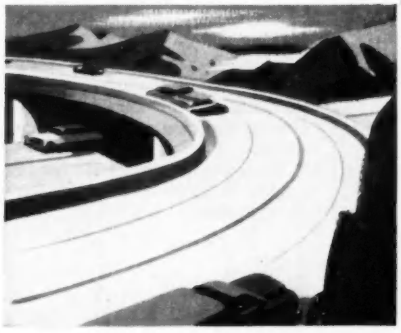


Keeping pace with automotive progress...



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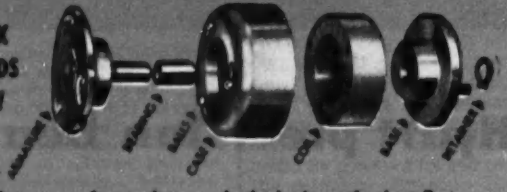

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Model Number	2	3	5	6	7	8
Diameter	1 1/16"	1 5/16"	1 5/8"	2 1/4"	2 1/2"	3 3/4"
Torque lb.-in.*	1/4	1	5	10	25	50
Weight lbs.	1/8	1/8	1/2	1	2 1/4	4 1/4

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provide quick, easy, and safe control. The most important reason for the hydraulic control system, then, is to provide power steering. The hydraulic system is a welcome relief to maintenance men, too, since they no longer have buses with frozen air systems.

By Peter Hay

Vickers, Inc.

OTHER advantages of the hydraulic power system which should be mentioned are:

Satisfactory operation in all climates.

Partial braking available the instant the engine is started, even with no oil in the accumulator.

Rapid pressure build-up.

No water cooling.

By S. I. MacDuff

Bendix Aviation Corp.

IF given a reasonable opportunity the hydraulic system will acquit itself admirably. It depends upon the willingness and ability of operators to learn how the system works, how to analyze troubles quickly so they can be corrected without wasting time and effort, and how to service the units economically and effectively. Many of the units are very similar to corresponding pneumatic units, but there are, of course, many differences and many little tricks in servicing and trouble shooting that will have to be acquired.

By F. W. Kateley

ACF-Brill Motors Co.

THERE may be many pros and cons regarding comparative cost and weight between hydraulic and compressed air systems. But the eventual choice may be dictated by whether or not the vehicle is provided with hydraulic power steering.

More Torque at High Speeds Is Engine Need

Based on paper by

H. L. WELCH

Chrysler Corp.

EVER since 1925 there has been a steady increase in hp per cu in. This is the result of developing more torque per cu in. at the speed of the power peak, and an increase in the speed at which the power peaks. Gains

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have been made in torque per cu in. throughout the speed range, but the greatest gains have been made at the higher speeds.

When we compare the high speed acceleration of our 1924, 1932, 1950 and 1952 models, we note a trend toward better acceleration at higher car speeds. It is also apparent that accelerating ability at higher car speeds has been significantly lower than at low speeds. Not only does the engine torque of each vehicle diminish at the higher operating speeds, but the torque required to maintain constant speed rises, primarily due to wind resistance. It should be remembered that low speed acceleration can be greatly aided by the transmission. However, standards are so high that maximum acceleration in first gear is often at the limit of rear wheel traction. The maximum available acceleration then decreases with speed due to progressively less gear ratio in the transmission until at about 65 mph the engine torque alone is transmitted to the rear axle. Unfortunately, at that speed, the engine torque curve is considerably past the peak.

We can expect the trend toward better accelerating ability at high speeds to continue. It is anticipated, therefore, that better torque at high engine speeds will be required of future engines. (Paper, "Trends in Chrysler Corporation Engines," was presented at a meeting of the SAE Detroit Section Junior Group, Oct. 20, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

Mechanism of Engine Deposits Under Probe

Based on paper by

J. C. STREET

Shell Petroleum Co., Ltd

This paper will appear in full in SAE Transactions

FUNDAMENTAL investigations into the mechanism of knock, involving the sampling of peroxides and aldehydes extracted from the end gas of a combustion chamber during the preflame period, have shown that the period in the cycle when tel exerts its antiknock action is between tdc and 10 deg L under the present test conditions.

In this work, which is still incomplete and from which only tentative conclusions can be drawn, the only compounds detected in the cycle have been lead oxybromides, lead oxysulphate, lead bromophosphate, lead oxy-

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phosphate, lead sulphate orthophosphate, and lead phosphate, depending on the fuel under test. At no time has free lead oxide been detected. This seems to be at variance with the modern view that at the time lead exerts its antiknock effect it is present in the form of lead oxide. Even if the above compounds are dissociated in the end gas there would still be no lead oxide in the case of the bromophosphate.

Thus it appears that if these compounds are not dissociated in the end gas during the appropriate time in the pre-flame reactions, then they must be equally effective as antiknocks as lead oxide itself. Since lead is thought to exert its antiknock action by a surface deactivation effect, this would mean that each of these compounds contains something common in the surface crystal structure which enables them to be effective. (Paper, "The Mode of Formation of Lead Deposits in Gasoline Engines," was presented at SAE National Fuels and Lubricants Meeting, Tulsa, Nov. 7, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

Based on Discussion

B. M. Sturgis
E. I. Du Pont de Nemours & Co.

A study made at Du Pont Laboratories supports many of the author's conclusions, but it also demonstrates that the role played by lead oxide is much greater than he indicated. It was believed that the simple lead salts —lead chloride, lead bromide, and lead sulphate—were formed in the combustion space by vapor phase reactions and deposited on the walls. Our investigation shows that this is probably not true, but that lead oxide is the only compound deposited on the walls under most conditions. After being deposited in the solid state, it can react with the acidic gases present in the combustion chamber, forming lead salts by gas-solid reactions.

If an engine is operated on a fuel containing no sulphur or halogens, essentially the only lead compound found on combustion chamber walls is lead oxide. Even when sulphur and halogens are present in the fuel, thermodynamic calculations show that lead oxide is the only lead compound which is stable at the gas temperatures existing during the expansion and exhaust strokes. The lead oxide, therefore, is deposited as such and later is converted to halides and sulphates.

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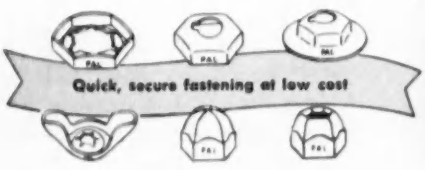

PALNUT TRADEMARK **LOCK NUTS**

Flight Tests Need Timing and Phasing

Based on paper by

M. C. BENEDICT
Westinghouse Electric Corp.

ANY aviation gas turbine comprises many dependent variables. It is impossible to solve all the unknowns simultaneously, therefore earliest efforts are aimed at achieving the desired characteristics of the fundamental variables, namely: compressor, diffusor, combustor, and turbine. Demonstration of this static performance is a major objective, which also establishes to a known degree the mechanical reliability of the bearings,

gearing, lubrication, and basic controls as well as basic components.

As soon after the static performance demonstration as is safe, acceptibility of the configuration over the obtainable operating range should be established by operation of the basic engine in flight and/or under simulated flight conditions. This starts Phase I testing in flying test beds. Following this comes the coordination of the remaining engine auxiliaries with the basic engine, then completion of the formal qualifications of the pilot production engine, followed by delivery of the new model for field use in prototype aircraft.

First flight in prototype aircraft launches Phase II testing. How much testing will be done depends on the extent of prior tests, the installation, and the difference in operating limitations between the prototype and the test bed. If Phases I and III are aggressive, the interference of engine development and airframe development is reduced to a minimum. During the second phase, the engine is incorporated in either the prototype or production aircraft depending upon the relative timing of the program.

Phase III flight testing by the engine companies to relieve the airplane contractor from continuing Phase II begins when a production airframe and related handling equipment are available. And it is continued as long as it serves any useful purpose. (Paper, "Timing and Phasing of Flight Testing in the Development of Engines," was presented at SAE National Aeronautic Meeting, Los Angeles, Oct. 4, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

True Rust-Preventive Oil Becomes a Reality

Based on paper by

E. F. H. Pennekamp
and
J. D. Oathout
Standard Oil Development Co.
and
D. B. McFadden
Humble Oil & Refining Co.

FORMATION of rust on inner surfaces of reciprocating aircraft engines which are temporarily idle or in storage presents a major maintenance problem. Rusting may be especially severe in new or rebuilt engines which are operated for short periods on leaded gasoline, then stored under conditions of high temperature and humidity—typical of tropical or subtropical areas.

Typical AN-VV-C-576b rust preventive oils are designed for break-in lubrication and engine protection during storage, but have not proved completely satisfactory either as rust preventives or as engine lubricants for fly-away service. Development of better oils has been hampered by lack of a suitable laboratory test.

Recently, however, a test was developed which simulates actual field conditions of full-scale engine operation and storage. The test involves operation of a single-cylinder aircooled engine and storage of the cylinder in a controlled cycle humidity cabinet.

This test has disclosed that the scavenging agent of leaded aviation

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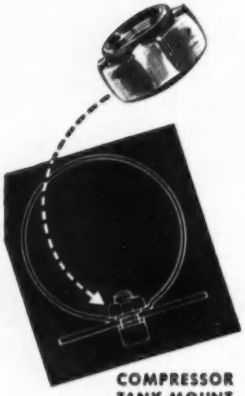
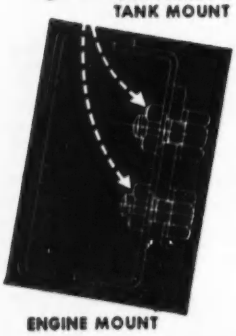

COMPRESSOR TANK MOUNT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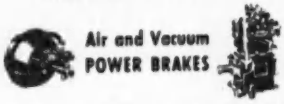
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Air and Electro-Pneumatic DOOR CONTROLS

gasoline is one of the primary causes of engine rusting during storage. No rusting was observed with clear gasoline or gasoline containing pure tetraethyl lead, but when 1-T Aviation Mix (one theoretical equivalent of ethylene dibromide in tetraethyl lead) or ethylene dibromide alone was added to clear gasoline, severe rusting occurred in the stored engines. It was also found that the type of base stock used in the lubricating oil has little or no effect on rust formation.

The test made it possible to investigate aviation oils containing additive combinations which would overcome the rust-forming tendencies of the scavenging agent and also provide complete lubrication without adverse effects on engine wear or combustion chamber deposits. Once screened by this method the compositions were given further test in full-scale engines under field conditions. As a result of this program, an ashless lubricant was developed which gives excellent protection against engine rusting and which can be used as a fly-away oil. (Paper, "The Development of Rust Preventive Lubricating Oils for Reciprocating Aircraft Engines," was presented at SAE National Fuels and Lubricants Meeting, Tulsa, Nov. 6, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

Based on Discussion

Capt. C. M. Murray, Wright Aeronautical Center, declared ashless rust preventive oils to be four times better than previous oils, but said that still better ones were needed.

Asked by **Melvin Young, Wright Aeronautical Corp.,** if there was a method for analyzing ashless oil activity so as to know when to change oil or added compounds, **Pennekamp** replied that they had a method, but that each supplier would probably have to develop his own, especially if different compounds were used.

100,000-Hp Aircraft Engines a Possibility

Based on paper by

O. T. KREUSSER

General Motors Corp.

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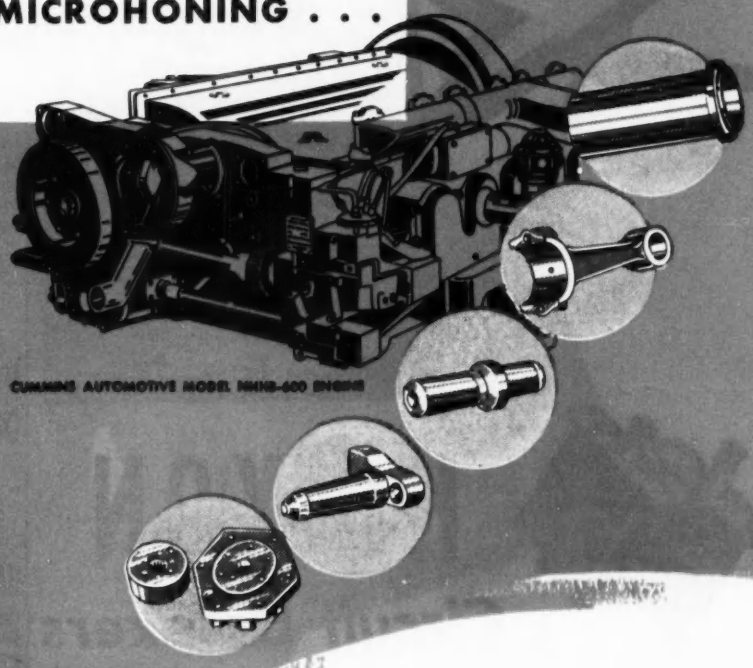

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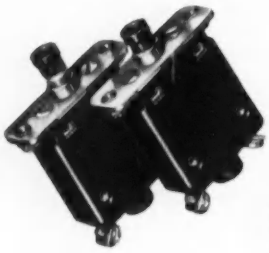

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and the power output of engines using hydrocarbon fuels. These materials, the expanding know-how, and testing facilities now in existence that were undreamed of 10 years ago, make possible engines of tremendous power. The feasibility of a 100,000 hp power unit is determined not by engineering and material limitations, but by economic practicability—that is, need for such a single power package.

The rocket engine using direct chemical reaction, and the atomic engine using nuclear fission in place of hydrocarbon fuels, will probably have to exceed the 100,000 hp outputs to be in practical competition with "what is new" in more conventional aircraft engines in the immediate years ahead. (Paper, "The Story of the First 50 Years of Aircraft Engines," was presented at the Centennial of Engineering, Chicago, Oct. 8, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers).

How Deposits Raise Octane Requirements

Based on paper by

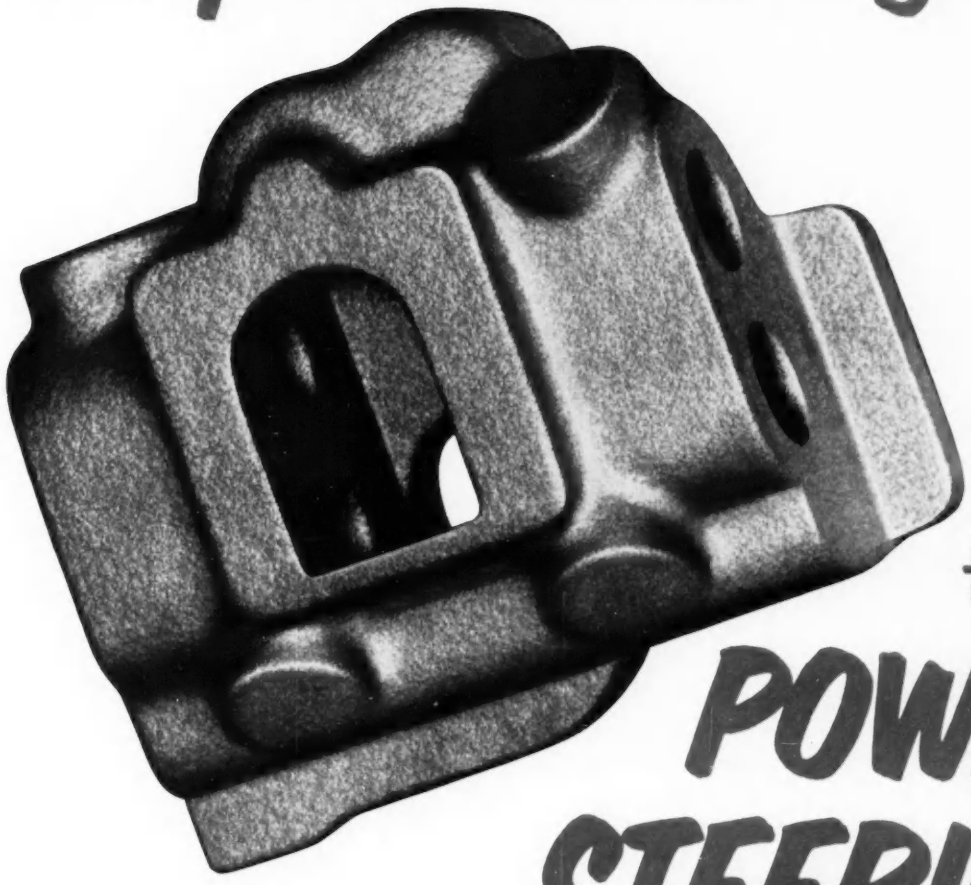
JAY BRENT MALIN

E. I. duPont de Nemours & Co.

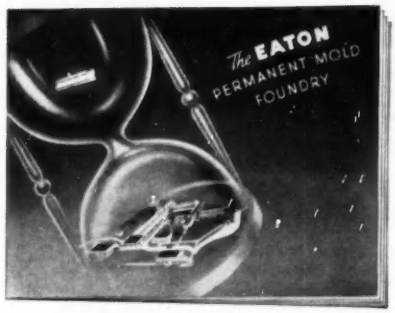
COMBUSTION-chamber deposits do cause an increase in engine octane requirement. But how do they do it? Before launching experiments, we postulated three main mechanisms as follows: (1) volume effect—deposits occupy physical space, hence they raise the compression ratio. (2) catalytic effect—deposits could catalyze reactions occurring in the fuel and accelerate knocking tendencies. (3) heat transfer—if deposits are good thermal insulators they could raise chamber temperatures and promote knocking.

We found through a series of tests that the volume of deposits accounts for somewhere between 20 and 40% of overall deposit knocking harm. If any catalytic effect exists, it is very small and certainly not important. On the other hand, the thermal resistance of deposits is a very important factor leading to octane requirement increase. The thermal insulation effect, plus the volume effect, accounts for about two-thirds to three-quarters of the total knocking harm, leaving a very small amount of harm to be accounted for through further tests. (Paper, "Combustion Chamber Deposits," was presented at SAE Northwest Section, Seattle, Oct. 6, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers).

Eaton Permanent Mold Gray Iron Castings—



for POWER STEERING



Send for your free copy of the 32-page illustrated booklet: "The Eaton Permanent Mold Foundry." It tells the story of Permanent Mold Castings and takes you on a picture-tour of the Eaton Foundry at Vassar, Michigan.

EATON MANUFACTURING COMPANY
General Offices: CLEVELAND, OHIO
FOUNDRY DIVISION: 9771 FRENCH ROAD • DETROIT 13, MICHIGAN

PRODUCTS: Sodium Cooled, Poppet, and Free Valves • Tappets • Hydraulic Valve Lifters • Valve Seat Inserts • Jet Engine Parts • Rotor Pumps • Motor Truck Axles • Permanent Mold Gray Iron Castings • Heater-Defroster Units • Snap Rings Springtites • Spring Washers • Cold Drawn Steel • Stampings • Leaf and Coil Springs • Dynamatic Drives, Brakes, Dynamometers

the chilled-iron face gives Eaton Tappets superior load-carrying capacity and longer life

To keep pace with the requirements of today's higher-speed, higher-compression engines, Eaton has developed special foundry facilities to produce chilled-face tappets with essential hardness and wear-resistant characteristics. Eaton offers volume-produced, volume-priced, lightweight tappets capable of carrying excessively high loads. From the ladle to final inspection, the wear-resistant hardness of the face and the over-all quality of Eaton tappets are guarded by precise metallurgical control.

EATON MANUFACTURING COMPANY

General Offices: CLEVELAND, OHIO

SAGINAW DIVISION: 9771 FRENCH ROAD • DETROIT 13, MICHIGAN

PRODUCTS: Sodium Cooled, Poppet, and Free Valves • Tappets • Hydraulic Valve Lifters • Valve Seat Inserts • Jet Engine Parts • Rotor Pumps • Motor Truck Axles • Permanent Mold Gray Iron Castings • Heater-Defroster Units • Snap Rings Springtites • Spring Washers • Cold Drawn Steel • Stampings • Leaf and Coil Springs • Dynamatic Drives, Brakes, Dynamometers

Students Enter Industry

Continued from Page 98

SOL NORMAN (Ohio State University '52) is a test engineer for General Electric Co. in Erie, Pa.

THOMAS O. NEWBY (Indiana Technical College '51) has been released from the Army and is now a junior engineer for United Specialty Co., Chicago, Ill.

JOSEPH C. MOPPERT, JR. (Northrop Aeronautical Institute '52) is a draftsman for North American Aviation, Inc., Inglewood, Calif.

CRAIG E. McCREARY (Northwestern University '52) is an ensign in the U. S. Navy stationed at the Naval Air Materiel Center, Philadelphia, Pa., where he is serving as a project engineer.

WILLIAM C. MENG (Parks College '52) has joined the Admiral Corp., Chicago, Ill., as a mechanical engineer.

MARTIN S. MARCINEK (University of Pittsburgh '52) is a junior test engineer for Pratt and Whitney Aircraft Division of United Aircraft Corp., East Hartford, Conn.

IGNATIUS G. KOSINSKI (University of Illinois '52) is a quality control trainee for Foote Brothers Gear and Machine Corp., Chicago, Ill.

LORANCE LEE WATSON (University of Colorado '51) is at the central engineering office of Chrysler Corp., Highland Park, Mich., as a project engineer.

ELLIOTT J. SIFF (Cornell University '52) is an assistant project engineer at Sperry Gyroscope Co., Great Neck, N. Y., while taking graduate work at Columbia University.

JAMES F. HINSON (Clemson College '53) has joined the American Appraisal Co., Cranford, N. J., as a mechanical appraiser.

JOHN A. BEETHAM (Parks College '52) is a lieutenant in the U. S. Air Force stationed at Lowry Air Force Base, Denver, Colo.

DON I. ESTUS (Oklahoma A. & M. College '52) is a second lieutenant in the Army at Fort Sill, Oklahoma.

PAUL D. SAYLOR (Bradley University '52) has joined U. S. Steel Corp. as an industrial engineering trainee at the Gary, Ind., works.

KENNETH G. RICE (Purdue University '52) is at the aircraft engine division of Ford Motor Co., Chicago, Ill., as project engineer in the product engineering department.

JOHN L. KING (A & M College of Texas '52) is a second lieutenant in

LET US HELP YOU HELP YOURSELF

Engineers who are genuinely serious about whittling down their engineering backlog welcome our engineering assistance over their peak work loads. Our main and most important work is in the automotive—engine and mobile equipment fields. We are expertly staffed and ready to serve you on short notice at a cost you can afford. Let us help you catch up now, speedily, economically.

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Mechanical Engineering
Research • Development
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O & S BEARINGS
NON-METALLIC • SELF LUBRICATING
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NO MATTER HOW YOU LOOK AT IT...
YOU'LL BE HAPPIER WITH O&S BEARINGS!
• NO MAINTENANCE
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WRITE FOR BULLETIN Number 251
OR SEND US PRINTS and DETAILS!
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Students Enter Industry

Continued

the Army's Chemical Corps Training Command at Fort McClellan, Ala.

HENRY J. ADAMS (A & M College of Texas '52) is now a second lieutenant in the U. S. Air Force stationed at Lackland Air Force Base, San Antonio, Texas.

STEPHEN A. BARA (University of Massachusetts '52) is a design engineer for Worthington Pump and Machinery Corp., Holyoke, Mass.

WILLIAM W. BARTON (Purdue University '52) has joined GMC's Allison Division, Indianapolis, Ind., as a junior engineer.

ARTHUR J. LARSEN (Wayne University '52) is a test engineer at the General Motors Technical Center.

R. A. SCHAKEL, JR., (Purdue University '50) is now an engineering officer aboard the U. S. Navy's Lake Champlain. Lieutenant Schakel recently completed a brief course in atomic warfare at Fort McClellan, Ala., and before that served aboard the aircraft carrier Leyte in Korean and Mediterranean waters for two years.

JOHN F. VIZZINI (Academy of Aeronautics '49) is an aviation cadet in the U. S. Air Force stationed at Vance Air Force Base, Enid, Okla.

BERTRAM C. ANDERSON (Northwestern University '51) is now an industrial sales engineer for Southern Counties Gas Co. in Los Angeles.

ROBERT C. BENKERT (Cal-Aero Technical Institute '52) is with United Aircraft Products, Inc., Dayton, Ohio, in the layout design department.

B. JAMES BERGMANN (Illinois Institute of Technology '52) is now a sales engineer for Foote Brothers Gear and Machine Corp., Chicago.

WILLIAM R. BLACKHAM (Northwestern University '52) is doing container manufacturing research for the American Can Co., Maywood, Ill.

DONALD A. WILLIAMS (University of Michigan '52) is an ensign at the Navy's Bureau of Ordnance, Washington, D. C.

JAMES H. CATES (Southern Methodist University '52) is a wireline man for Otis Pressure Control, Inc., Corpus Christi, Texas.

DONALD W. BOSSEMEYER, JR. (Purdue University '52) has joined GMC's Guide Lamp Division, Anderson, Ind., as a junior engineer.

EDWARD H. WILLIAMS (University of Massachusetts '52) is a student

NEED MORE THAN JUST A HEATER?

THIS EVANS *Fresh Air* UNIT IS CUSTOM ENGINEERED AS A COMPLETE HEATING AND VENTILATING SYSTEM

EVANS FEATURES PROVIDE HEAVY-DUTY DEPENDABILITY WITH SERVICE-FREE PERFORMANCE

1.
2.
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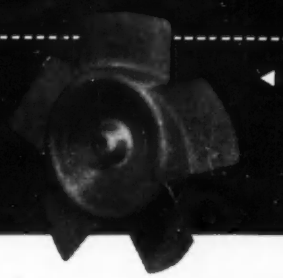


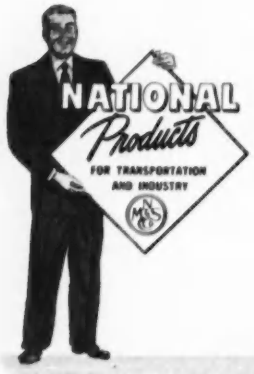
EVANS ENGINEERING IS AVAILABLE TO HELP SOLVE YOUR PROBLEM

The Evans organization is staffed to engineer promptly an installation to your specifications, organized to build prototypes quickly, equipped to conduct precision tests to latest A. S. H. V. E. procedures. Military experience dating back to World War I qualifies Evans to work well with you in meeting the rigid specifications of the Armed Forces. If your needs are for high performance, ruggedly constructed automotive heating and ventilating equipment—custom built to your specifications—it will pay you to consult *Evans Products Company, Heating & Ventilating Division, Dept. Z-2, Plymouth, Michigan.*

BALANCED HEATING & VENTILATING
CUSTOM HEATERS
FOR EVERY TRUCK AND BUS

Castings by National

selected for Quality and Dependability



Products bearing these familiar trademarks have all established enviable reputations for quality and dependability.
These manufacturers *continue* to procure castings by National—one of the Nation's largest founders.

NORTHWEST
EATON
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Budd
CATERPILLAR
AMERICAN-STANDARD PRODUCTS
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National's unparalleled experience in producing malleable, heat-treated malleable, and steel castings is at your disposal. Sales offices and engineering facilities are located at all five strategically located plants. A-5346

PLANTS LOCATED IN Sharon, Pa., Cleveland 6, Ohio, Indianapolis 6, Ind., Melrose Park, Ill., and Chicago 50, Ill.

SEE "This Moving World"

A 16mm technicolor film. Narrated by Edwin C. Hill, this 27-minute film tells how malleable iron is made . . . tested . . . used . . . how its production economy, ductility, machinability, toughness will give you a better finished product. Available for group showings.

NATIONAL Products FOR TRANSPORTATION AND INDUSTRY

NATIONAL MALLEABLE and STEEL CASTINGS COMPANY
CLEVELAND 6, OHIO
Est. 1868

Students Enter Industry

Continued

officer in the U. S. Air Force stationed at Keesler Air Force Base, Miss.

MARCOS HADJES (Cal-Aero Technical Institute '52) is now in Brazil as technical adviser for Companhia Brasileira Desenvolvimento, Comercio & Industria.

M. V. WEBB, JR. (Southern Methodist University '52) is a research and development engineer for Dow Chemical Corp., Freeport, Texas.

JAMES D. TRUESDALE (Parks College '52) is with McDonnell Aircraft Corp., St. Louis, Mo., as a stress analyst.

ROBERT B. SCHULTZ (Pennsylvania State College '52) is in training with the RCA Victor Division of Radio Corp. of America in Camden, N. J.

ROBERT H. TRAVER (University of Wisconsin '52) is a design engineer for Qualitrol Corp., East Rochester, N. Y.

RICHARD W. SLY (Michigan College of Mining and Technology '52) is a junior engineer in the training program of Fairbanks Morse & Co., Beloit, Wis.

JAMES E. WEBB (Clemson A & M College '52) is in the drawing department of the Tennessee Valley Authority, Knoxville, Tenn.

JAMES TERRIS (University of British Columbia '52) is with the Canadian Gulf Oil Co., Calgary, Alberta, as a student engineer.

DONALD L. COUCHMAN (University of California '52) is a test engineer for General Electric Co., Schenectady, N. Y.

HARRY E. BRENNAN (University of Massachusetts '52) has joined General Electric Co. in Pittsfield, Mass., as a manufacturing trainee.

ROBERT E. CURBOY (Parks College '52) is a field service instructor for North American Aviation, Inc., Columbus, Ohio.

EUGENE E. YOUNG (Syracuse University '52) is with North American Aviation, Inc., Columbus, Ohio, as engineering draftsman.

BRUCE HANNA (Chrysler Institute of Engineering '52) is now with the Coleman Motors Co., Littleton, Colo.

FRED C. WELTY (Northrop Aeronautical Institute '52) is now a co-pilot for United Air Lines, Inc., Los Angeles.

KENNETH D. TARBELL, JR. (Northrop Aeronautical Institute '52) is a data reduction engineer for Northrop Aircraft, Inc., Hawthorne, Calif.

New Members Qualified

These applicants qualified for admission to the Society between Dec. 10, 1952 and Jan. 10, 1953. Grades of membership are: (M) Member; (A) Associate; (J) Junior; (SM) Service Member; (FM) Foreign Member.

Canadian Section

Nels Anthony Dario (J), John Kurelek (J), Herbert Aubrey Staneland (J).

Central Illinois Section

George H. Benedict (J), John Corser (M), Robert Allan Kirk (J), Frederick William Riddell (M).

Chicago Section

Robert L. Bassett (A), John Robert Bowling (J), Edward W. Christiansen (J), Chester J. Cole (J), William Czapar (J), Howard P. Freers (J), Clarke T. Goethel (J), Leon R. Henry, Jr. (J), John J. Kadlec (M), J. Gordon Knapp (M), Donald Dawson MacKenzie (J), Gordon C. Olson (J), Lone O. Reedy (M), Joseph Francis Szekely (J), John P. Walsh (J).

Cincinnati Section

Joseph S. Alford (M), Max Richard Gramly, Jr. (J), Ralph J. Schmidt (M).

Cleveland Section

Charles Balough, Jr. (A), Robert Galen Farr (J), Elmer Dale Galey (A), Paul Thomas Johnson (J), George Nicholls Lounsbery (J), Donald F. Rader (A).

Colorado Group

Paul Gustav Anderson (J).

Dayton Section

Walter J. Sharrock (J), Donald D. Weidhuner (J).

Detroit Section

Theodore Wm. Bayler (J), Niels J. Beck (J), Robert J. Benya (J), Howard A. Buchanan (A), Robert Emmett Conklin (J), Paul M. Corp (M), Edward C. Cozzarin (J), William C. Dorr (J), Robert C. Gatzke (M), Henry N. Godbey, Jr. (J), Thomas Golec, Jr. (J), Herbert J. Hannigan (A), Alfred N. Iknayan (M), Raymond C. Johnson (J), Stephen L. Mathewson (M), Carroll R. McBeth (M), Robert Ames Meacham (J), Clarence H. Parrish, Jr. (M), Ralph Joseph Rays (J), Glenn D. Reinders (J), Lawrence H. Robertson (M), Thomas F. Roth (J), Richard Glenn Ruffe (J), Robert Lee Simpkins (M), Anthony J. Suchoski (J), Vernard Taylor (J), Paul P. Thomas (J), John R. Turunen (J), Lorance L. Watson (J), Mitchell Wayne (M), G. B. Wiklund (A).

Hawaii Section

John Ferguson Mellen (J), Max E. Suder (A).

Continued on Page 136

Protect . . .

TRANSMISSIONS

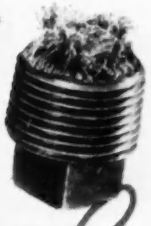
with

LISLE MAGNETIC PLUGS

You can eliminate a common cause of noise trouble in transmissions by installing LISLE PLUGS as original equipment. Metal particles that flake off moving parts and circulate in lubricants are attracted and held by the strong, permanent magnet in the LISLE PLUG, thus preventing costly maintenance.

REPLACE ORDINARY PLUGS WITH LISLE PLUGS

TO REMOVE IRON AND STEEL PARTICLES FROM OIL



SAMPLE PLUGS for testing furnished FREE of charge. Just state size and type of plug desired.

LISLE Corporation

1903 50th ANNIVERSARY 1953 CLARINDA, IOWA

Making History on the Mesabi

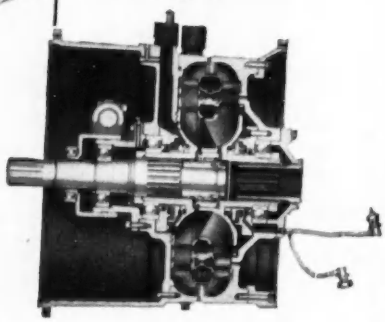
with TWIN DISC'S exclusive braking feature Torque Converters...

Twin Disc's *three-stage* Hydraulic Torque Converters, proved superior for heaviest off-highway haulage, are making history on the Mesabi and in similar hauling in the mining, construction and logging industries.

The exclusive feature of Twin Disc *Truck Type* Torque Converters is a down-hill braking action. Mesabi range drivers find that even on the toughest grades, the vehicle can be kept at a reasonable speed by the *converter braking action* without the use of brakes. Down-hill, converter combines with engine to perform 90% of the braking.

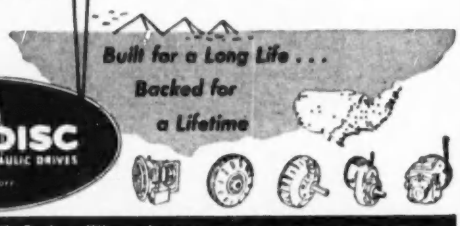
Up-grade, Twin Disc converters provide highest torque multiplication; automatically match engine power to load and grade through an infinite number of ratios to keep the engine *always* working in the efficiency range.

But most important of all, Twin Disc Torque Converters prevent shock loading of drive line and engine—*all the time*. Differentials, drive axles and final drives now stand up for more than 10,000 actual working hours . . . or twice former normal expectancy. Tires last much longer. Engine life, too, has been extended for these same reasons.



Twin Disc Torque Converters for trucks provide highest torque multiplication—practically eliminate uphill gear shifting—help perform most of braking. Model DF has selective braking and direct drive for longer hauls; Model CF provides automatic braking with constant torque converter drive . . . best suited to short, steep hauls.

Like all Twin Disc Hydraulic and Friction Drives, Twin Disc Truck Type Hydraulic Torque Converters are "built for a long life—backed for a lifetime". Complete stocks of service parts and complete replacement units are carried at Twin Disc's 8 Factory Branches and 60 Parts Stations, strategically located to provide quick service.



TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin • HYDRAULIC DIVISION, Rockford, Illinois

BRANCHES: CLEVELAND • DALLAS • DETROIT • LOS ANGELES • NEWARK • NEW ORLEANS • SEATTLE • TULSA

New Members Qualified

continued

Indiana Section

Burl B. Baber, Jr. (J), Paul L. Bracht (J), Harvey F. Dick (J), Fred F. Fox (M), Wendell H. Kern (M), Richard O. Mason (J), Richard O. McHenry (J), Robert P. Moore (M).

Kansas City Section

Ben D. Mills (M), William F. Spreen, Jr. (M), Harvey L. Wise (A), Charles S. Young (M).

Metropolitan Section

Paul C. Boyd (A), John E. Epprecht (M), Alfred M. Fischer (M), Sheldon Fox (J), Norbert J. Hertel (J), Michael Kowalchik (J), Walter J. Ross (A), Herbert Wallace Saltzman (J), Albert R. Thomas (M), Charles A. Weisel (M).

Mid-Continent Section

Joseph G. Evans (A), Laurence D. Reis (M).

Mid-Michigan Section

Jack K. Barnhart (J), Norton J. Nichols (M), Leonard C. Price, Jr. (J), John A. Rizzardi (J), Wayne H. Watling (M).

Milwaukee Section

A. L. Kreul (A), T. G. Shedore (A).

Mohawk-Hudson Group

William H. Radtke (M).

New England Section

Paul A. Henneforth (A).

Northern California Section

James B. Edwards (M), James Charles Loar (A).

Northwest Section

Walter Mark Isaac (J), Floyd Charles Layton (J).

Oregon Section

Richard Eugene Crandall (J).

Philadelphia Section

Herbert Barness (J), H. L. Decker (M), Charles J. Gregorovich (J), Paul Horn (A), Hugh Robertson Jackson (J), Frank Lynne Martin (M), Richard Henry Marvin (M), Carl S. Nau (J), Eugene M. Polter (J).

Pittsburgh Section

Earl Allan Bake (J), Malcolm Faulkner Judkins (M), Donald Frederic Kendrick (J).

San Diego Section

Arthur C. Durson (J), William H. Whitley (J), James R. Woodward (J).

Southern California Section

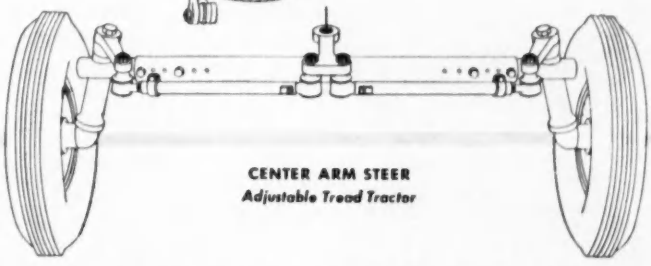
Donald E. Bowman (M), Clarence Samuel Brown, Jr. (J), Joseph Milroy

Continued on Page 138

Engineered Steering for All Wheeled Vehicles

PARALLELOGRAM LINKAGE
Solid Center Link

FORE-AFT AND CROSS STEER
Steering Gear Ahead of Axle



CENTER ARM STEER
Adjustable Tread Tractor

STEERING LINKAGE must be developed to meet the problems peculiar to many sets of design conditions. For over 50 years Thompson's "Steering Engineers" have worked closely with manufacturers of all types of wheeled vehicles to develop and produce the best steering linkage for any type vehicle.

Illustrated here are typical examples of steering linkage produced by Thompson for passenger cars, for trucks and buses and for tractors.

Whether your problem is improved steering for a car, a truck or a tractor, the Detroit Division of Thompson Products has, or can engineer and produce, the steering linkage best adapted to the vehicle you produce. We welcome the opportunity to work with your engineers on any of your steering problems. Please contact us.

YOU CAN COUNT ON...

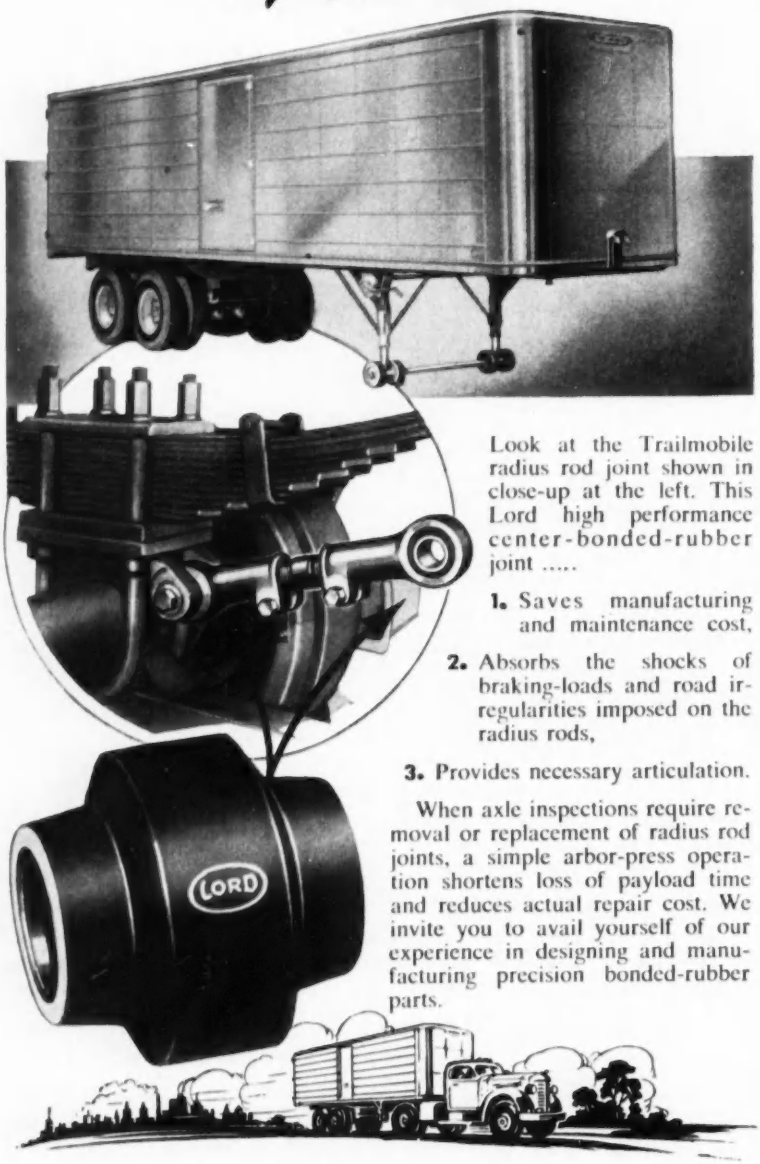
Thompson Products, Inc.

DETROIT DIVISION

7881 Conant Avenue • **Detroit 11, Michigan**

TRAILMOBILE

RADIUS ROD JOINTS *by* LORD



Look at the Trailmobile radius rod joint shown in close-up at the left. This Lord high performance center-bonded-rubber joint .....

1. Saves manufacturing and maintenance cost,
2. Absorbs the shocks of braking-loads and road irregularities imposed on the radius rods,
3. Provides necessary articulation.

When axle inspections require removal or replacement of radius rod joints, a simple arbor-press operation shortens loss of payload time and reduces actual repair cost. We invite you to avail yourself of our experience in designing and manufacturing precision bonded-rubber parts.

BURBANK, CALIFORNIA 233 South Third Street
DALLAS, TEXAS 413 Fidelity Union Life Building
PHILADELPHIA 7, PENNSYLVANIA 725 Widener Building
DAYTON 2, OHIO 410 West First Street
DETROIT 2, MICHIGAN 7310 Woodward Ave.
NEW YORK 16, NEW YORK 280 Madison Avenue
CHICAGO 11, ILLINOIS 520 N. Michigan Ave.
ERIE, PENNSYLVANIA 1635 West 12th Street

LORD MANUFACTURING COMPANY • ERIE, PA.

LORD — BONDED RUBBER

Headquarters for **VIBRATION CONTROL**

New Members Qualified

continued

Brown (J), L. H. Clark (A), Bartrem Grenfell Doupe (M), Thomas M. Epperson (J), Charles F. Hoppe, Jr. (M), Harold P. Johnson (M), Joseph Patrick Lynch (J), Alan Tower Ries (J), James H. Ryder (M), Vernon L. Stephan (J), Glen E. Stillwell (A), Dale R. Thompson (J).

Southern New England Section

Arno G. Kalb (J), Joseph V. Krason (J), Harvey Joseph Lander (J), Robert P. Lotreck (J), Edward Richard Luff (J), Charles F. Smith (J).

Syracuse Section

Burton D. Jones (J).

Texas Section

Wolf J. Beyer (M), Robert H. Jones (M), J. L. Osburn (M), Robert L. Pons (J), B. P. Robertson (M), Abraham Tucker (J).

Twin City Section

Joseph D. Menth (J), Kenneth F. Potter (M).

Williamsport Section

Franklin S. Frederick (J).

Outside of Section Territory

Roy E. Barker (A), George W. Bird (M), James D. Carmichael (J), Charles Aubrey Davidson (J), Charles F. Eisele (A), Jack E. Gregg (J), Thomas Linder, Jr. (M), Hugh McBain (M), F. R. Meehan (M), Grover Clinton Mellin, Jr. (J), Dwight H. Pearson (J), J. Waldo Seiple (M), Howard Raymond Wright, Jr. (M).

Foreign

Max E. Lawton (FM), South Australia.

Applications Received

The applications for membership received between Dec. 10, 1952 and Jan. 10, 1953 are listed below.

Atlanta Group

George W. Peckham, Clarence C. Whiten.

Baltimore Section

Maurice Elmer Ensor, Oscar Francis Klaburner, Sidney Laham.

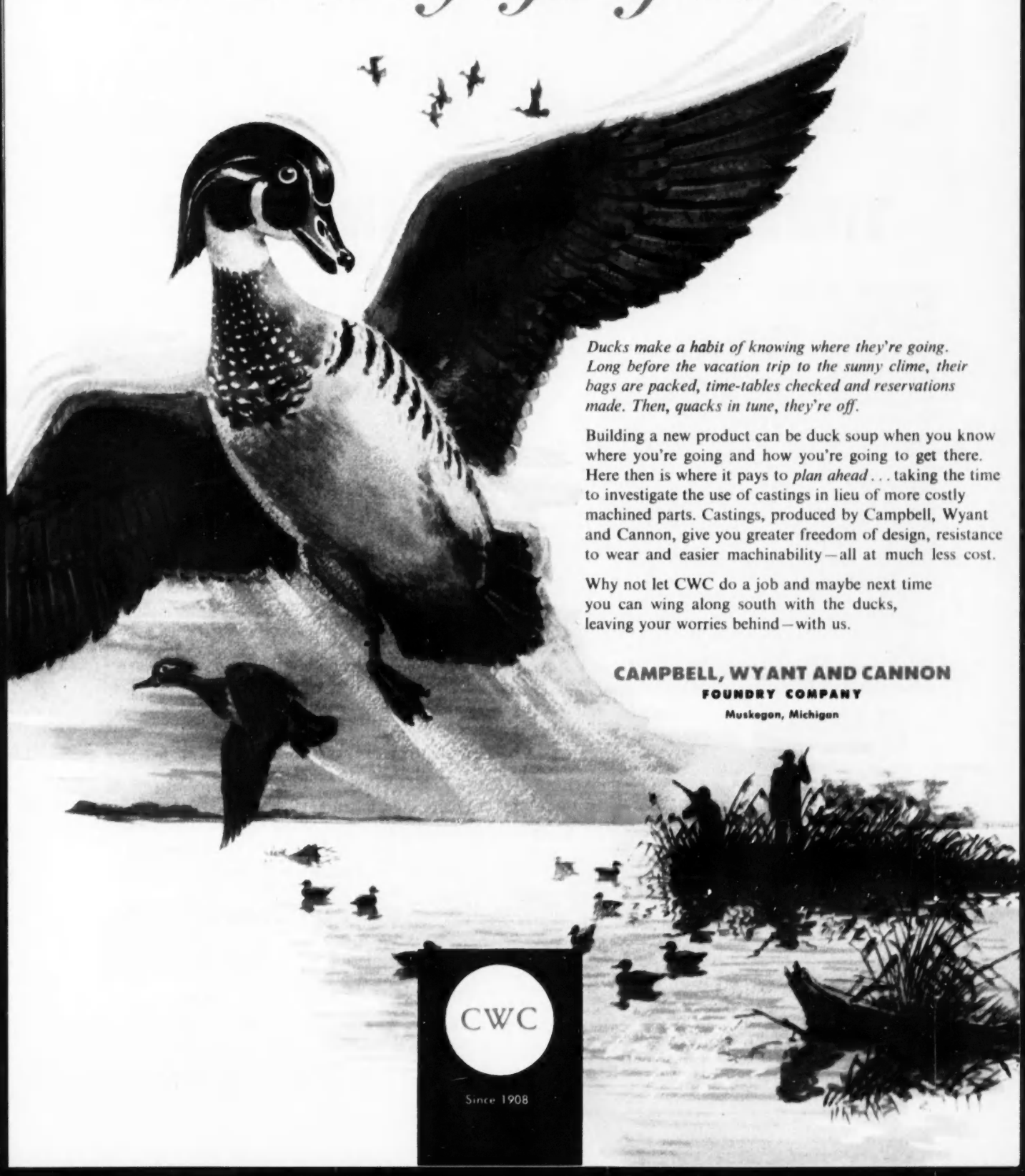
Buffalo Section

Heinz Mueller, Raymond J. Zwolenkiewicz.

Continued on Page 141

YOU'LL NEVER SEE

a duck flying blind



Ducks make a habit of knowing where they're going. Long before the vacation trip to the sunny clime, their bags are packed, time-tables checked and reservations made. Then, quacks in tune, they're off.

Building a new product can be duck soup when you know where you're going and how you're going to get there. Here then is where it pays to *plan ahead*... taking the time to investigate the use of castings in lieu of more costly machined parts. Castings, produced by Campbell, Wyant and Cannon, give you greater freedom of design, resistance to wear and easier machinability—all at much less cost.

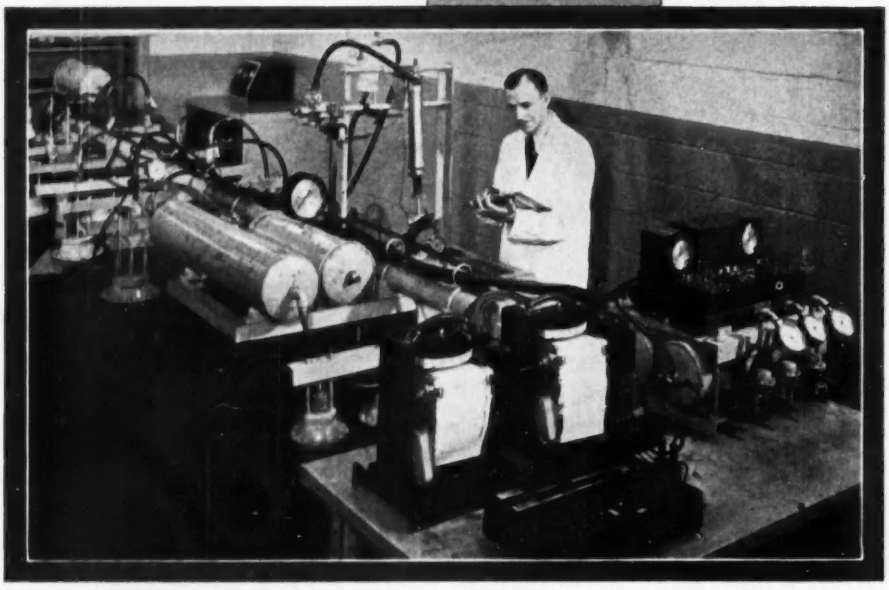
Why not let CWC do a job and maybe next time you can wing along south with the ducks, leaving your worries behind—with us.

CAMPBELL, WYANT AND CANNON
FOUNDRY COMPANY
Muskegon, Michigan

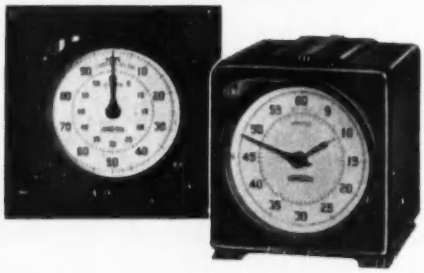
CWC

Since 1908

TIME TO STOP...IN TIME!



SPLITTING THE SPLIT SECOND at the Bendix-Westinghouse Engineering Research Department laboratories is absolutely essential in exploring every possible braking requirement for transportation tomorrow.



STANDARD ELECTRIC TIME has been serving industry, government and educational institutions for almost seventy years with fine precision instruments and equipment for the accurate measurement of time.

STANDARD ELECTRIC MODEL S-1 Clocks are a part of the modern laboratory controls testing equipment and timing devices shown in this photograph... they accurately measure air brake application and release transmission time to one-hundredth of a second... The timers are started instantaneous to brake pedal movement transmitted through an electronic circuit and are stopped by means of a highly sensitive electro pneumatic switch located at pre-determined stations in the air brake system.

STANDARD
SINCE 1884

THE STANDARD ELECTRIC TIME COMPANY
87 LOGAN STREET • SPRINGFIELD 2, MASSACHUSETTS

Applications Received

continued

Canadian Section

Joseph A. Atzberger, John Harold Cane, Ernst Willy Portmann, George Adolphe Sherl, Robert C. Smith.

Central Illinois Section

Vergil Phillip Hendrickson, Milton B. Holland, D. C. McCann, James W. Schoonover.

Chicago Section

William C. Allen, Harry T. Kessler, Donald J. Kullmann, Ellis R. Larson, Wayne W. Lehto, Milton C. Neul, John E. Starr, Arthur F. Szydlowski.

Cincinnati Section

LaVern D. Murray, J. S. Parker, E. V. Sharpnack, Sr.

Cleveland Section

Peter A. Asseff, Joseph B. Boynton, Robert C. Dyrenforth, Jr., John V. Gallagher, Thomas A. Healy, Richard Allen Koss, John V. Koteles, Leland H. Schmohl, Robert V. Snyder, Kenneth Joseph Sorace, Lloyd E. Sump.

Dayton Section

Daniel E. Krause, David G. Uitti.

Detroit Section

Raymond J. Bergin, Leo B. Bielecki, Irving Noble Bishop, Herman F. Borcherts, Paul Chuba, Pedro Lorenzo Delgado, Donald J. Deitrick, Christopher Michael Drew, Charles W. Duffy, Darius D. Dustman, Robert R. Furney, Robert E. Gleason, Lester M. Goeman, Richard B. Harper, Edgar S. Haskin, Richard William Heater, Charles E. James, Jay Winfield Kreusser, Anthony Kushigian, Douglas Sidney Lee, C. Robert Lomneth, Gene H. McDonald, James J. Nance, Edwin A. Nielsen, George C. Nowicki, Loren R. Papenguth, Milan Pribich, Robert P. Reilly, Louis E. Rhodes, Victor A. Rusnack, Donald James Schwalm, Arthur Schwartz, August J. Scussel, Frank William Sinks, Jerome D. Vanek, Eugene A. Wingerson, Nicholas J. Wyles.

Indiana Section

Charles I. Cutter, Levi C. Mock, Robert W. Secrest, Jr.

Kansas City Section

Earl R. Allgeyer, Eugene P. Bailey, William D. Hoener, Jack C. Marshall, Russel K. Rourke.

Metropolitan Section

Otto Erich Balje, Robert W. Brattvet, Laurence Clements, Wallace I. Goddard, Joseph P. Hamer, Nat Hellman, III, Howard Holmes, Irwin D. Miller, Anthony Orsini.

Mid-Continent Section

Clarence D. Hodgson, Joe P. Stagner.

Continued on Page 142

Nearly five centuries ago Leonardo Da Vinci invented this aerial screw—a forerunner of the present-day helicopter.
... out of this came Aviation
... an industry with imagination
To serve this great industry there are many manufacturers with imagination and vision. Indiana Gear is such a company—a group of able craftsmen equipped with the best of tools and machines—producing the finest in precision parts. At I.G.W. we accept the challenge of this and all other precision industries. We will match their visionary design with creative production.
Indiana Gear fabricated this large steel ring gear for the main transmission of a recent model Sikorsky Helicopter without grinding and without heat treat distortion. Originally, the helical teeth on this gear were ground, but a necessary power increase overloaded the part and it failed.
It was assumed to be impossible to successfully heat treat the unground teeth, but I.G.W. produced the part without distortion and the gear operated successfully.
INDIANA GEAR
INDIANA GEAR WORKS, INC. • INDIANAPOLIS 7, INDIANA

Applications Received

continued

Mid-Michigan Section

Dale H. Winfield.

Milwaukee Section

Morris L. Hutchens, F. S. Kubiak, Arnold F. Lueders, Lyle George Munson, Swaraj Vrat Panjratan, Berger Velander, Jerrold B. Winther.

Mohawk-Hudson Group

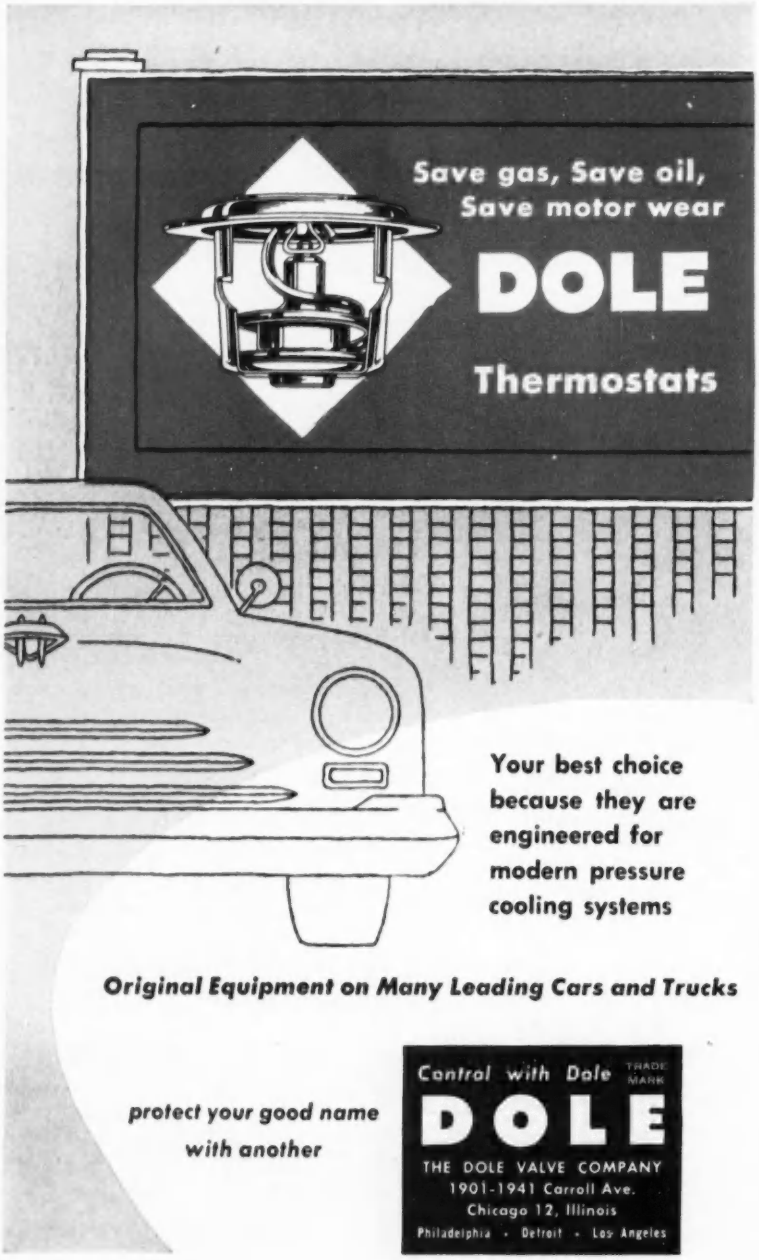
Curtis Garwood Talbot.

Montreal Section

R. J. DiCicco, H. R. Elstone, Thomas George Hunter, John W. Korcz, Jack E. Reichelt.

New England Section

Charles A. Caliri, Ellsworth G. Cameron.


Save gas, Save oil,
Save motor wear
DOLE
Thermostats
Your best choice because they are engineered for modern pressure cooling systems
Original Equipment on Many Leading Cars and Trucks
protect your good name with another
Control with Dole TRADE MARK
DOLE
THE DOLE VALVE COMPANY
1901-1941 Carroll Ave.
Chicago 12, Illinois
Philadelphia · Detroit · Los Angeles

Northern California Section

Frank T. Kataoka, Vernon Theodore Nelson.

Northwest Section

Robert E. Johnson.

Philadelphia Section

Nijad Ahmed Ceylan, George W. Francks, Arthur Fuerman, John R. Pichtelberger, Gregory Joseph Siragusa.

Pittsburgh Section

M. George Breyer, Fred W. Fest, Jr., H. R. Fife, John W. Hood, A. J. Parsons, William G. Stanier.

St. Louis Section

Joseph Claude Anderson, Joseph M. Levon.

Salt Lake Group

Frederick J. Blatz, Jr., Ray O. Girton, J. D. Lawson.

Southern California Section

Julius Joseph Davis, Raymond C. Forsnas, Frederick S. Howard, Arthur J. Iler, William S. Kozica, David G. Lewis, Gernot Strauss.

Southern New England Section

Donald R. Olson.

Spokane-Intermountain Section

M. F. Rice.

Syracuse Section

Fred J. Michel.

Texas Section

E. J. Clements, William Preston Goode, Paul R. McMahan, Anthony F. Solla.

Washington Section

Robert Burkhardt, Norman C. Witbeck.

Western Michigan Section

William Carpenter, John Margil Simonetti.

Wichita Section

Lewis A. Paul.

Williamsport Group

Albrecht W. Hussmann.

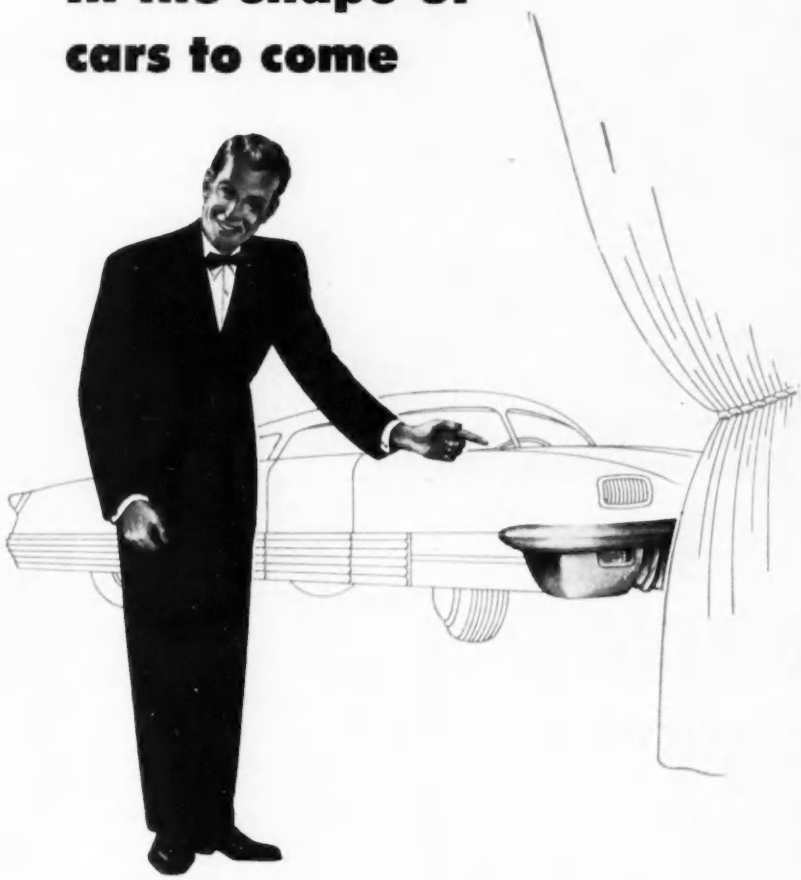
Outside of Section Territory

Nathaniel T. Bartholomaei, James Whitman Buckley, Jesse R. Gardner, Herman Gerber, Orvin Ellsworth Flint, William Lloyd Holmstrom, James E. McDowell, David K. Nason, Henry J. Rasmussen, John Toper, George N. Turner.

Foreign

Fazal Ahmad, Pakistan; Francis John Eames, France; Hassan Mohamed El-Sabilgi, Egypt; Sigvard Forssell, Sweden.

In the shape of cars to come



Distinctive Bumpers by . . .

Standard Steel Spring Company

MAIN OFFICE: CORAOPOLIS, PA.

PLANTS: Allegan, Mich. • Gary, Ind. • Chelsea, Mich. • Chicago, Ill. • Logansport, Ind. • Coraopolis, Pa. • Newton Falls, Ohio • Detroit, Mich. • New Castle, Pa. • Los Angeles, Calif. • Trenton, N.J.

DISTRICT OFFICES: 1600 Fisher Building, Detroit, Michigan, Peoples Gas Building, Chicago, Ill.

RESEARCH LABORATORY: Coraopolis, Pa.

DIVISIONS

and their products

BUMPERS

STANDARD STEEL SPRING CO.
Coraopolis, Pa.
Newton Falls, Ohio

UNIVERSAL JOINTS

BLOOD BROS. DIVISION
Allegan, Mich.

COIL, PRECISION AND MECHANICAL SPRINGS

MUEHLHAUSEN SPRING DIV.
Logansport, Ind.

CHELSEA SPRING DIV.
Chelsea, Mich.

OPEN STEEL FLOOR GRATING

STANDARD STEEL SPRING CO.
Gary, Ind.

CORRONIZING

STANDARD STEEL SPRING CO.
Coraopolis, Pa.

ARMOR PLATE

ARMOR PLATE DIV.
Detroit, Mich.

SEAT CUSHIONS, BACK SPRINGS

FALLS SPRING AND WIRE DIV.
Detroit, Mich.

GREAT LAKES SPRING DIV.
Chicago, Ill.

STANDARD STEEL SPRING CO.
Los Angeles, Calif.
Trenton, N. J.

FLAT LEAF SPRINGS

STANDARD STEEL SPRING CO.
Gary, Ind.
New Castle, Pa.

TUBULAR SEAT FRAMES

FALLS SPRING AND WIRE DIV.
Detroit, Mich.

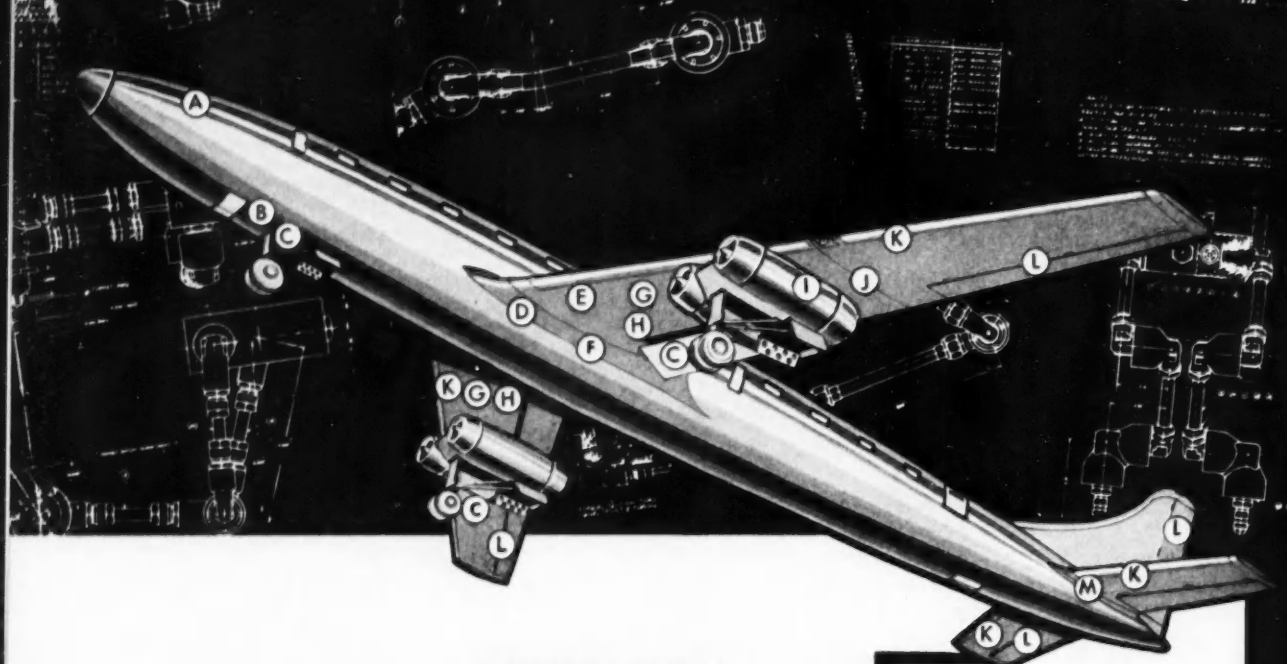
GREAT LAKES SPRING DIV.
Chicago, Ill.

TUBULAR PRODUCTS

FALLS SPRING AND WIRE DIV.
Detroit, Mich.

SSS

"Not A Flight of Fancy"



HERE ARE WAYS CHIKSAN CAN HELP AIRFRAME MANUFACTURERS

The airplane shown here is not an actual picture of any one plane. Rather, it is a composite to show some of the varied ways in which Chiksan planning can help the airframe manufacturer do a better job.

Fuel, oil, water, air and oxygen all find dependable, safe, uninterrupted flow through Chiksan aero-hydraulic swivel joints and assemblies.

CHECK THESE APPLICATIONS IN YOUR BLUEPRINTS:

A. Refueling boom assembly
B. Steering control mechanism
C. Brake system
D. Spoiler actuating mechanism
E. Fuel and oil lines
F. Adjustable sweep-back system
G. Emergency dump chute
H. Flap actuating system
I. Power-plant fuel and oil lines
J. Wing fold
K. De-icing system
L. Power control system
M. Stabilizer trim

A few of the many Chiksan aero-hydraulic swivel joints made for pressures ranging from 1000 to 3000 psi.

The Flow of Enterprise Relies on

CHIKSAN

Ball-Bearing Swivel Joints

REPRESENTATIVES IN PRINCIPAL CITIES

CHIKSAN

CHALLENGING JET PROBLEMS FOR CREATIVE ENGINEERS

- **Reducing jet engine cost and weight by using plastics.**
- **Developing materials capable of withstanding 2000 degrees F.**
- **Designing lightweight, reliable electronic control circuits.**
- **Increasing air flow through a fixed diameter compressor.**

These are typical problems that General Electric engineers face and solve in the design and development of new and advanced aircraft turbojet engines at Jet Center, U.S.A. near Cincinnati, Ohio.

The solutions to jet engine design problems depend upon imaginative minds. Keen analytical thinking and vision are "musts" in this rapidly-advancing field.

If these are the challenges you seek, your opportunity is available with G.E. at Evendale, Ohio, headquarters for General Electric's Aircraft Gas Turbine Division.

Here you will be part of the great and growing American jet engine industry that G.E. pioneered just 10 years ago! You will work with other top creative engineers who are probing into the vast unknown areas of jet propulsion.

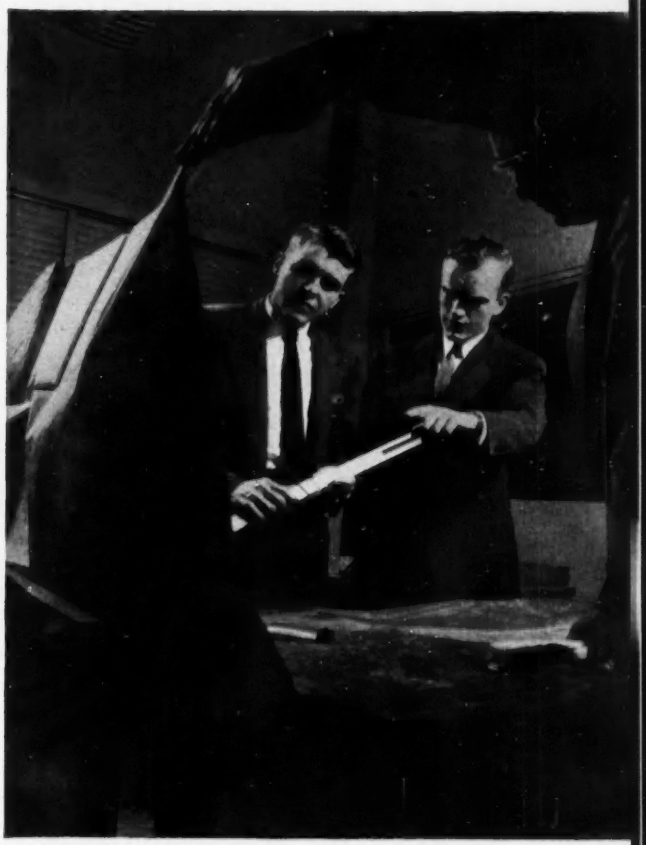
Here are the opportunities open to you with General Electric in the jet engine industry:

AERODYNAMICS	HEAT TRANSFER
FLUID MECHANICS	HYDRAULICS
THERMODYNAMICS	ELECTRONICS
TESTING	INSTRUMENTATION
WELDING	LUBRICATION
VIBRATION AND DAMPENING	METALLURGY
LABORATORY ENGINEERING	FLIGHT MATHEMATICS
STRESS ANALYSIS	FIELD ENGINEERING

CREATIVE MECHANICAL DESIGN
SERVO-MECHANISMS

Positions are available at West Lynn, Mass. and Cincinnati, Ohio. Please do not apply if your best skills are being used for vital defense work. Send your resume to: Technical and Supervisory Personnel, Aircraft Gas Turbine Division, Dept. S.

GENERAL ELECTRIC
P.O. BOX 196 CINCINNATI 15, OHIO



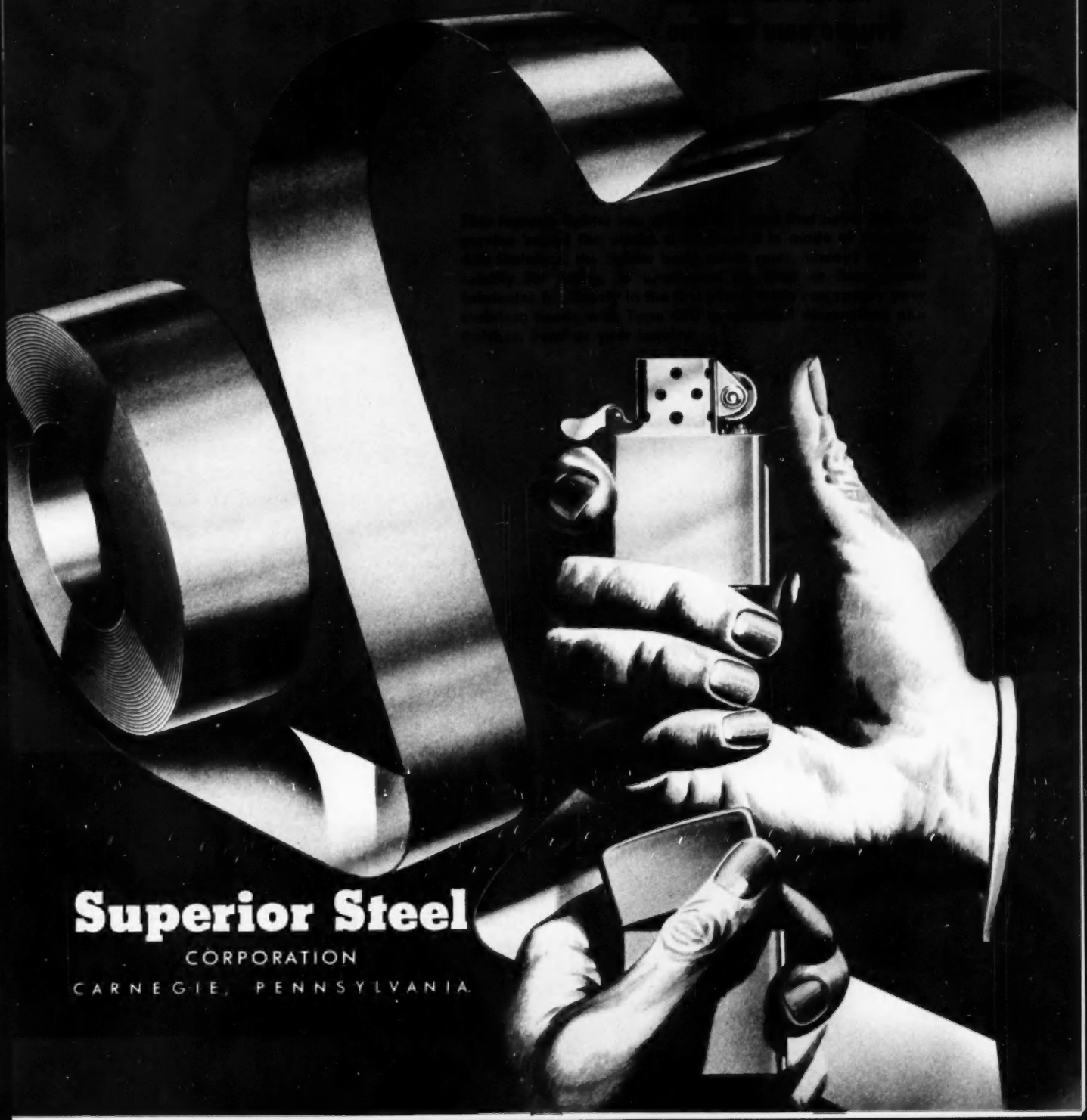
TURBOJET ENGINEERS — Future jet problems at G.E. need the knowledge, creative thinking, and stamina of keen-minded engineers. Independent thought coupled with joint endeavor produce new and better jet engines.

IN NAVY BLUE — New fighter for the Navy's carrier fleet is the North American FJ-2 "Fury." Powered by a new model of the combat-proved J47 engine, this Navy fighter will be a potent part of America's air arm. Among other planes powered by G-E jets are Boeing's B-47 Stratojet bomber, and North American's F-86 Sabrejet fighter and F86-D Sabrejet Interceptor.

AEROQUIP
Always first
ON ALL AIRCRAFT
Aeroquip
REG. TRADE MARK
FLEXIBLE HOSE LINES with detachable, reuseable fittings
AEROQUIP CORPORATION, JACKSON, MICHIGAN
SALES OFFICES: BURBANK, CALIF. • DAYTON, OHIO • HAGERSTOWN, MD. • HIGH POINT, N. C. • MIAMI SPRINGS, FLA.
MINNEAPOLIS, MINN. • PORTLAND, ORE. • WICHITA, KAN. • TORONTO, CANADA
AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN U.S.A. AND ABROAD

TYPE 430

The Heart of the Lighter



Superior Steel

CORPORATION

CARNEGIE, PENNSYLVANIA

SEALED TO ORDER BY VICTOR

MODEL "60" SERIES ENGINE

FEATURES VIC-2-FOLD SEALING

To the John Deere technical staff, the merits of VIC-2-FOLD cylinder head sealing were readily apparent. Here is the modern development of metal-asbestos gasket structure. The best characteristics of copper, steel, and asbestos are fully utilized. VIC-2-FOLD can be made as thin as needed, yet with adequate compressibility for positive sealing. Strength and durability are increased by this Victor construction.

Sealed by Victor Means Satisfaction

Take a close look at VIC-2-FOLD design, at right, as did John Deere engineers. Here, or in the complete Victor line may be a far better value in automotive sealing products than you're now getting. Your inquiry invited; no obligation.

VIC-2-FOLD

. . . THE MODERN METAL-ASBESTOS CYLINDER HEAD GASKET

Note how the high strength of steel is utilized in the bottom layer. Combustion openings are turned up, overlapping top copper layer, giving strong protection against breakdown and blowout.

In coolant openings, copper top layer is formed down, utilizing copper's higher resistance to corrosion in contact with coolants and anti-freeze solutions.

Compressibility of VIC-2-FOLD gaskets is precisely controlled by the use of finest long fiber asbestos millboard, milled in Victor's own plant.

Where can we help you get better sealing?

Victor Manufacturing & Gasket Co., *and its affiliate,* Victor Sealing Products Co., Inc., P. O. Box 1333, Chicago 90, Ill.

VICTOR GASKETS AND OIL SEALS — SEALING PRODUCTS THROUGH RESEARCH

VICTOR

"ORIGINAL EQUIPMENT"

Gaskets and Oil Seals

SEALING PRODUCTS *EXCLUSIVELY*

STOP

WASTING TECHNICAL TALENT

Turn over your special fastening problems to *specialists* . . . trained fastener engineers who have been through the trial-and-error stage in this highly specialized field and can free your own engineering staff for finished-product engineering.

It pays. We've proved it . . . for leading manufacturers in the automotive industry . . . and in the electronics, aviation, appliance and furniture industries, too.

United-Carr and its subsidiaries have had years of experience in the design and production of *tailor-made* fasteners and allied devices. Each division of the company provides a reservoir of special knowledge for the others. The result: an integrated organization that makes use of every improvement in materials and methods to produce fasteners that *speed assembly, cut costs* and, in many cases, actually *improve product performance.*

With complete facilities in our own plants for the volume production of special metal stampings and for the assembly of metal to plastic and ceramic components, we are in a position to supply practically any fastening need.

Before bidding on government contracts requiring fasteners or special fastening devices, consult your nearest United-Carr field representative.

UNITED-CARR

MAKERS OF DOT *FASTENERS*

UNITED-CARR FASTENER CORPORATION, CAMBRIDGE 42, MASSACHUSETTS

8 reasons why... Delco Shock Absorbers lead in acceptance!

1 ***Individually Engineered***—*Only Delco offers a complete line of shock absorbers in types, sizes and capacities needed for each application.*

2 ***Uniform Ride***—*Exclusive spiral reservoir tube improves performance and maintains uniform control under extreme operating conditions.*

3 ***Riding Comfort***—*Two major design developments permit Delco shock absorbers to give the best in riding comfort—Delco's self-cleaning duplex compression valves . . . and Delco double control pistons.*

4 ***"Sealed for Life"*** *Construction—Completely welded sealed-in unit for long life and increased safety.*

5 ***Durability***—*Exclusive Delco "Multi-Lip" seal is actually four seals in one—four times better—prevents fluid loss.*

6 ***Faster Response***—*Delco's short orifices permit quicker response to road conditions.*

7 ***Highest Quality***—*Precision construction throughout minimizes wear and increases life.*

8 ***Strict Conformance to Specifications***—*Delco shock absorbers are inspected 100% for ride control characteristics.*

Delco leads the field in production facilities, engineering development and product performance. That is why Delco is original equipment on more new cars and trucks than any other make. Cars equipped with Delco shocks give a better ride on *all* types of roads. Delco Products, Division of General Motors Corporation, Dayton, Ohio.

Delco Hydraulic Shock Absorbers

Since the early days of the industry, Permite engineers have cooperated closely with automotive engineers in piston design and development for better engine performance.

Today's powerful, smooth-running engines give testimony to the fact that progress never stops in the automotive industry, or with those suppliers who contribute to its high requirements.

As a dependable source of supply for pistons, valves and other engine parts to meet today's high standards, Permite's long experience and complete facilities are at your service.

ALUMINUM INDUSTRIES, Inc. . . . Cincinnati 25, Ohio

Detroit: 809 New Center Building
New York: 9 Rockefeller Plaza
Chicago: 64 E. Jackson Boulevard

ALUMINUM PERMANENT MOLD AND SAND CASTINGS . . . HARDENED, GROUND AND FORGED STEEL PARTS

A product is known by the company it keeps. The makers of MICROLITE, the featherweight insulation blanket that literally soaks up sound, are proud to be associated with America's leading motor car manufacturers.

When critical resonance areas are insulated with MICROLITE, unwanted and annoying sounds are dissipated in the millions of tiny air spaces packed into this amazing material. The result: a quiet, restful ride that bespeaks the very quality of the car itself.

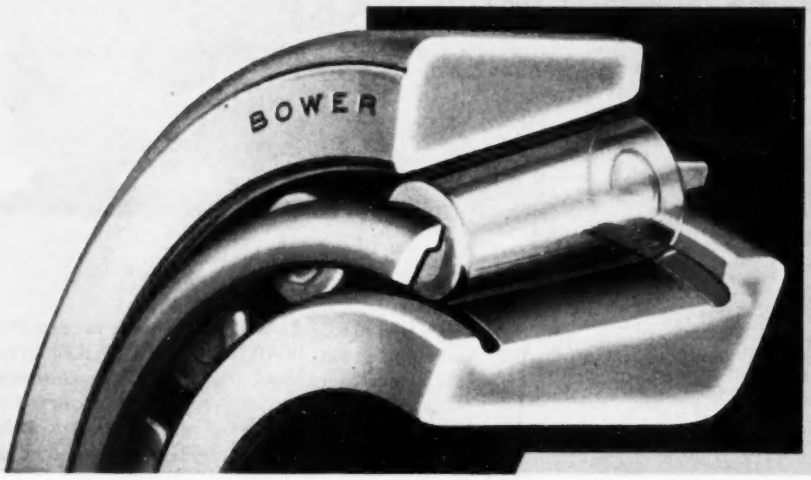
QUIET
MICROLITE* AT WORK

GLASS FIBERS INC.

TOLEDO, OHIO

Automotive Insulation Sales Representatives: A. C. Olfs and D. B. Burleigh, 3-225 General Motors Building - Detroit, Michigan

Bower spher-o-honed design provides better bearing lubrication



LARGE OIL GROOVE GIVES POSITIVE LUBRICATION TO ROLLER HEADS

The large oil groove built into Bower Spher-O-Honed bearings is just *one* of several important Bower design features which reduce maintenance and increase efficiency. Combine it with generated spherical roll-heads and a higher flange surface, and smooth, precision-honed races, and you have the basic elements of Spher-O-Honed design.

A careful look at the illustration above will show you other important Bower features, too. Note particularly that the roller heads contact the flange over a wide two-zone area—thus reducing wear and minimizing resultant "end play."

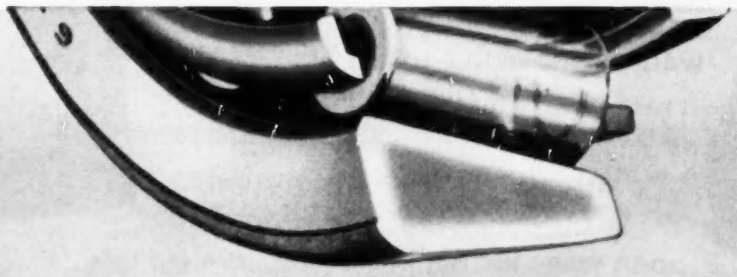
Built of the highest quality materials and workmanship, Bower bearings are available in a complete range of sizes and types to meet your present requirements. Call in a Bower engineer now!

BOWER ROLLER BEARING COMPANY • DETROIT 14, MICHIGAN

BOWER

ROLLER BEARINGS

SPHER-O-HONED

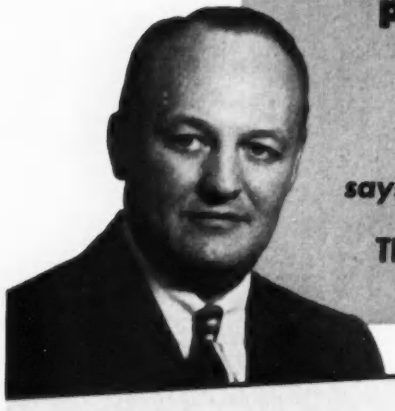


A COMPLETE LINE OF TAPERED, STRAIGHT AND JOURNAL ROLLER BEARINGS

"Wagner Air Brake Systems

provide adequate air for our hundreds of stops daily in Chicago metropolitan traffic"

says: H. L. WILLETT, JR.
EXECUTIVE VICE-PRESIDENT
THE WILLETT COMPANY
CHICAGO, ILLINOIS



THE Willett COMPANY
700 SOUTH DESPLAINES STREET • CHICAGO 7 ILLINOIS • MONROE 6-1493

October 10, 1952

Wagner Electric Corporation
6400 Plymouth Avenue
St. Louis 14, Missouri

Gentlemen:

We lease heavy-duty tractor units to all types of haulers in the Chicago area. These units are in constant use and have to operate efficiently if we are to maintain our standards of service. Because of this we consider the air brake system of vital importance--it must be a safe system in operation, yet require a minimum of maintenance in our shop.

We specify Wagner Air Brakes when ordering new equipment because the Wagner Rotary Air Compressor, in our opinion, has the greatest air recovery and assures us trouble-free operation at all times. We know Wagner Air Brake Systems provide adequate air for our hundreds of stops daily in Chicago metropolitan traffic. Another of its principal advantages is the ease of installation--especially the size and compactness of the rotary air compressor. We have experienced little or no difficulty with the units we've installed. Such an outstanding record is the reason why we recommend Wagner Air Brakes and Wagner Rotary Air Compressors to owners of other heavy vehicles.

Sincerely yours,

Howard L. Willett Jr.

H. L. WILLETT, JR.
Exec. Vice-President

HLW.JR.. jr

Willett Motor Coac... Willett Truck Leasing Company • Willett Transports Inc.

Men like Mr. H. L. Willett, Jr., have proven for themselves that WAGNER AIR BRAKES give them maximum freedom from maintenance worries and cut costly repair jobs on their brake systems. Much of the credit for this record of dependable service is largely due to the WAGNER ROTARY AIR COMPRESSOR—the compressor that assures an adequate supply of air at all times. Many fleets report that even after *years* of service they have never had a single compressor failure on units equipped with a WAGNER ROTARY AIR COMPRESSOR. Users like its simplicity of design, compactness of size, ease of installation, and economy.

If you install dependable, trouble-free WAGNER AIR BRAKES as standard equipment it will help buyers of the vehicles you manufacture keep maintenance at a minimum. You can get full details on WAGNER AIR BRAKES by sending for your free copy of WAGNER Bulletin KU-201A. Mail your request today.

WAGNER AIR BRAKE USERS ARE OUR BIGGEST BOOSTERS

Wagner Electric Corporation
6378 PLYMOUTH AVENUE, ST. LOUIS 14, MO., U. S. A.
(Branches in principal cities in U. S. and in Canada)

LOCKHEED HYDRAULIC BRAKE PARTS and FLUID...NoRol...CoMoX BRAKE LINING...
AIR BRAKES...TACHOGRAPHS...ELECTRIC MOTORS...TRANSFORMERS...INDUSTRIAL BRAKES

K53-3A

IN DAILY OPERATION, MILLIONS OF TRUCKS AND CARS DEMONSTRATE DEPENDABILITY OF

DSP production controls give you maximum "expectancy" from design characteristics—provide "stand-up" under the most severe usage—your insurance against costly premature failures in service.

That is why the makers of the majority of America's light and heavy trucks use DSP Springs as original equipment—why DSP has grown with the automotive industry since 1904.

Automotive Division

DETROIT STEEL PRODUCTS COMPANY

Also Makers of Fenestra *Building Products*

2250 E. Grand Blvd. • Detroit 11, Michigan

SINCE 1904—ORIGINAL EQUIPMENT ON CARS, TRUCKS, CABS, BUSES, TRAILERS

They Haul Oil, Machinery and Ice Cream

Yet They have One Advantage in Common

It would be hard to select three vehicles that vary more in design and purpose than these. But dissimilar as they are, they all share one important feature—each is built with low-alloy, high-strength Mayari R.

There seems to be no limit on the types of trucks, trailers and other highway vehicles that can be built better with this versatile steel. In some instances vehicle designers are interested primarily in increasing strength; in some they are interested solely in reducing deadweight without sacrificing strength; in others they aim at a middle course by combining a moderate increase in strength with a corresponding reduction in deadweight. Engineers have their choice when they work with Mayari R.

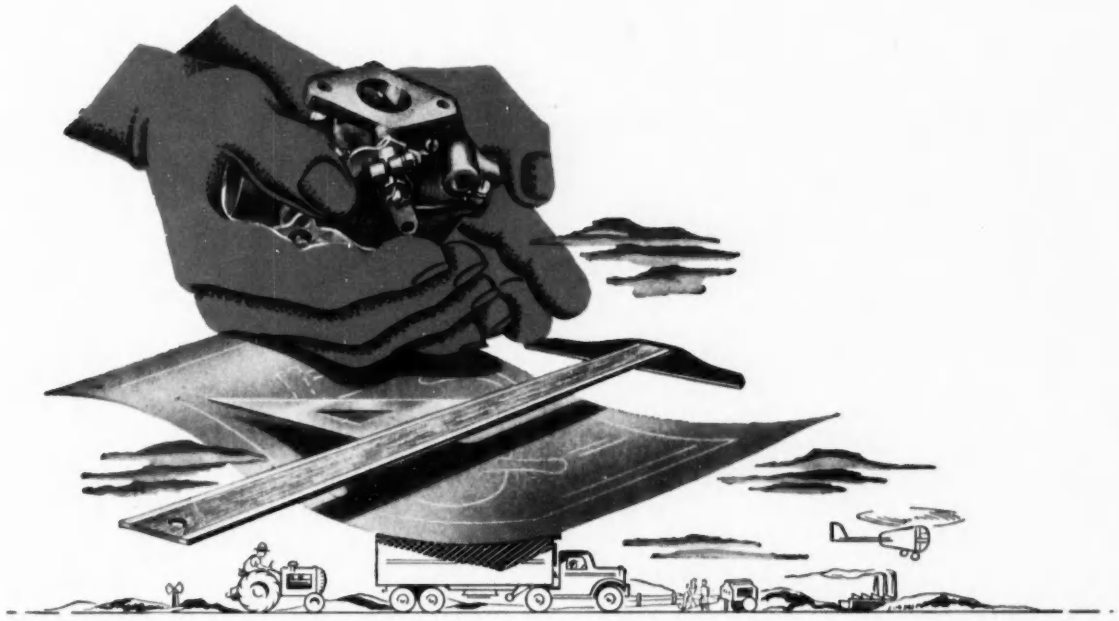
Another thing that can be counted on with this steel is increased resistance to atmospheric corrosion. Mayari R will resist corrosion damage 5 to 6 times longer than plain carbon steel of equal gage. It will also retain paint up to 80 pct longer, depending upon the composition of the paint used.

Get more information on Mayari R. Take advantage of its properties to improve your present designs. Our Catalog 259 will explain Mayari R features and applications in detail.

BETHLEHEM STEEL

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation



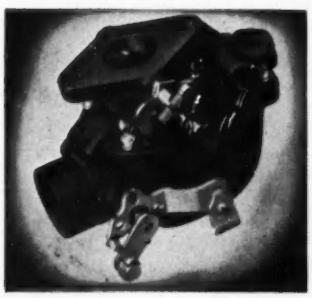
Look to field application engineering to increase your engine performance

For many years, in many diversified markets, Marvel-Schebler has concentrated on designing and adapting carbureters to meet individual requirements.

In order to satisfy all kinds of load demands, in all kinds of weather, Marvel-Schebler has relied on performance data supplied by field application engineering to help engine manufacturers obtain carbureters of proper design and calibration.

This has resulted in a constantly expanding wealth of experience in carbureters and carburetion for a wide range of applications. In the farm field alone, where rugged strength and unusual dependability provide that extra margin of economy in operation, 6 out of 10 farm tractors are using Marvel-Schebler carbureters as original equipment.

This experience can be of great help to you in the proper selection of standard equipment from the Marvel-Schebler line or in any of your carburetion problems. It is yours for the asking.

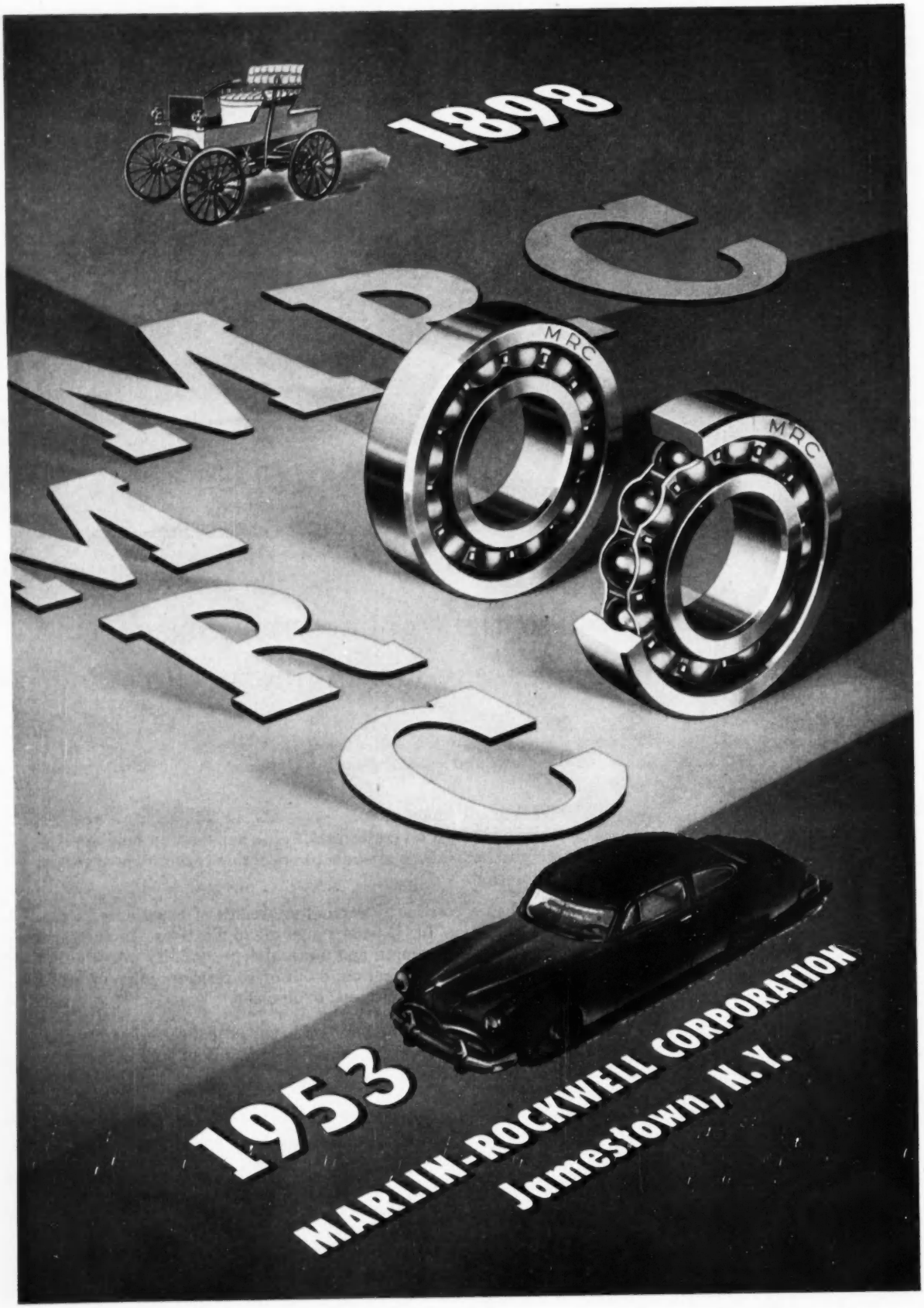


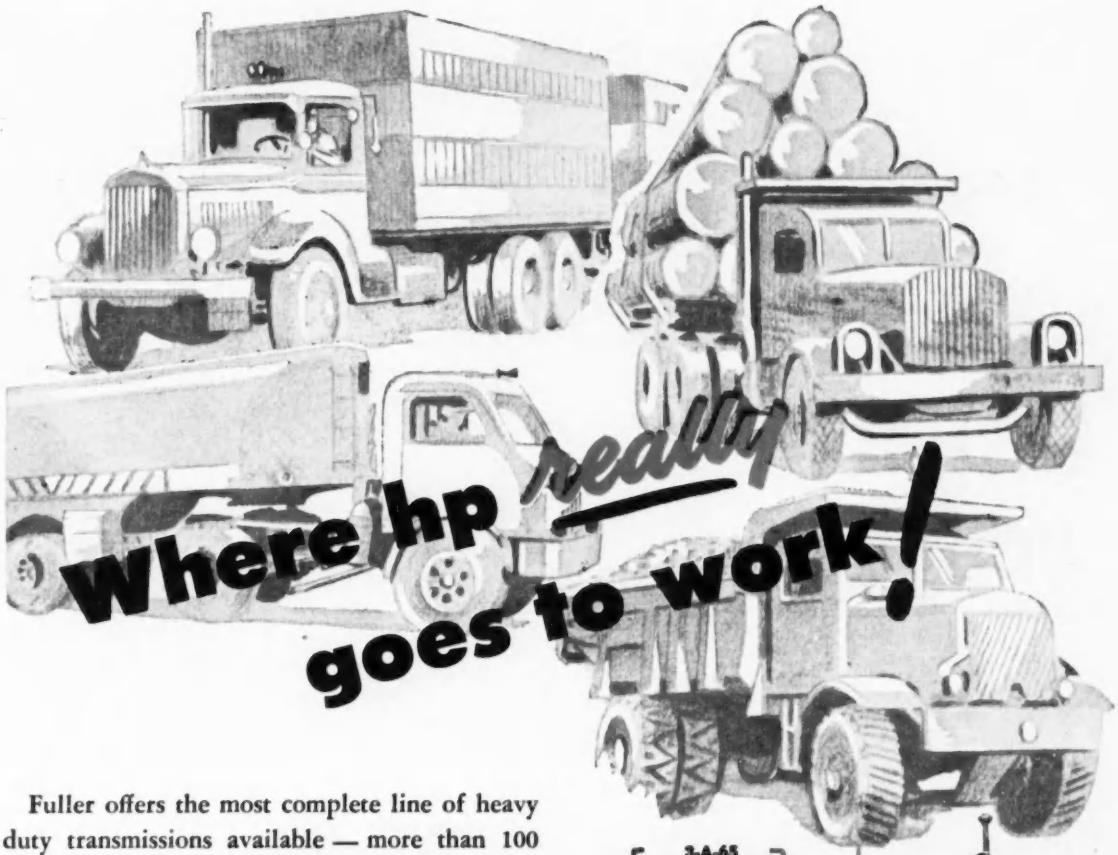
MARVEL-SCHEBLER PRODUCTS DIV.

Borg-Warner Corp., Decatur, Ill.

B-W ENGINEERING PRODUCTION

MARVEL - SCHEBLER *Carbureters*


1898
MRC
MRC
MRC
1953
MARLIN-ROCKWELL CORPORATION
Jamestown, N.Y.

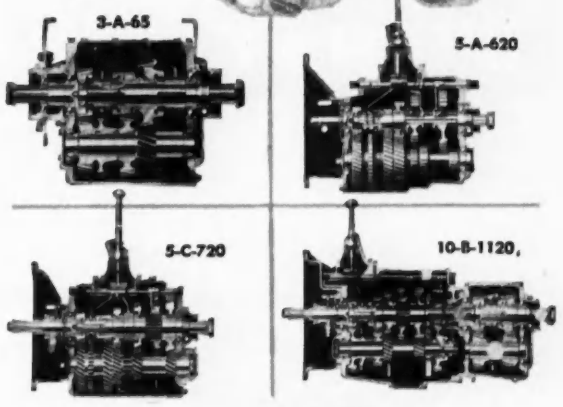


Where hp *really* goes to work!

Fuller offers the most complete line of heavy duty transmissions available — more than 100 models—for every heavy duty application using internal combustion engines.

There's a Fuller unit or auxiliary transmission for any application—from two tons to the biggest —to provide exactly the *right gear ratios* for your job—to help your driver keep the engine turning at its most effective speed . . . to assure faster trips —higher average speeds.

That's why you see the Fuller name plate on the gear boxes of more and more trucks and industrial machines. Demand transmissions from the *Fuller* line to get maximum performance from *your* rigs.



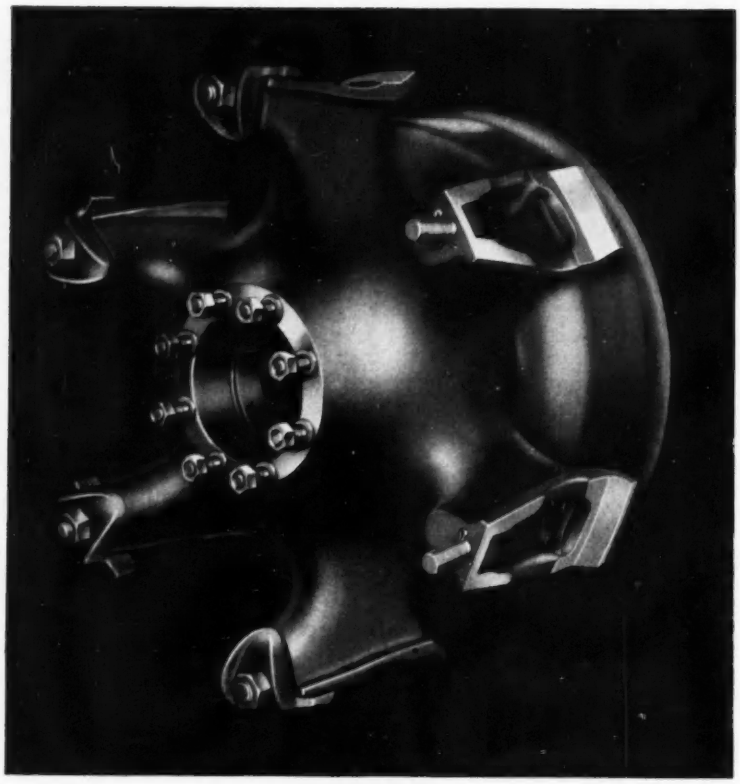
where horsepower *really* goes to work

Fuller TRANSMISSIONS

FULLER MANUFACTURING COMPANY (Transmission Division), KALAMAZOO 13F, MICHIGAN

Unit Drop Forge Division, Milwaukee 1, Wis. • WESTERN DISTRICT OFFICE (SALES & SERVICE—BOTH DIVISIONS), 1060 E. 11th Street, Oakland 6, Calif.

WHERE WEIGHT COUNTS



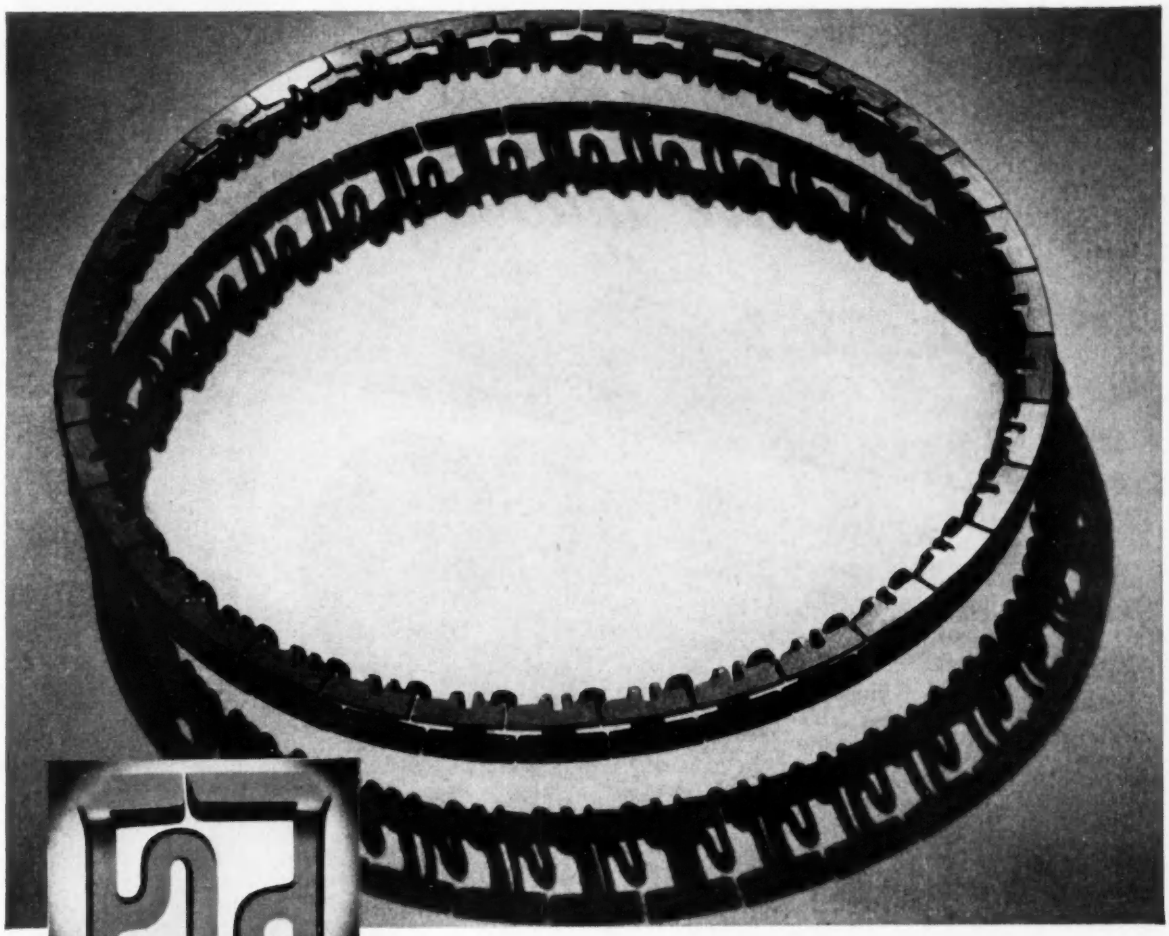
GUNITE WHEELS

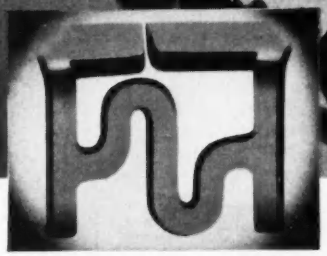
DESIGN TELLS THE STORY

Gunite truck and trailer wheels are skillfully engineered to stand the gaff of "peak-load" operation. Tubular spoke design provides maximum strength through accurate weight distribution. Six low-torque floating rim bolts assure easy-servicing and true alignment with rim clamp. Made of fine-quality cast steel, Gunite tubular-spoke wheels are rugged . . . yet, save vital pounds . . . assure minimum unsprung weight . . . cut costs per every mile of operation. Best of all, you can specify Gunite lightweight cast-steel wheels at no premium in price.

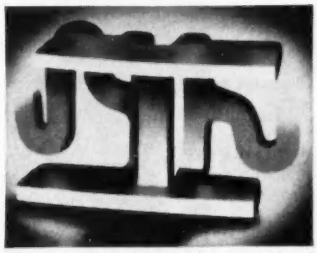
GUNITE

GUNITE FOUNDRIES CORPORATION, Rockford, Illinois

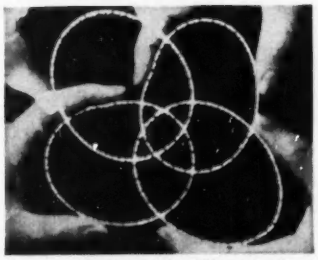




The exclusive "S" design prevents buckling or wavering when compressed.



This exclusive strut support in every sector of Sealed Power Flex-S assures flatness and stability for both upper and lower lands during up and down strokes and when changing direction.



Because of its extreme flexibility and uniform radial pressure, Sealed Power Flex-S conforms perfectly to tapered and out-of-round bores.

Announcing the revolutionary Sealed Power

flex-S

flexible steel oil ring

YEARS of research, designing, engineering, and testing preceded this announcement of the Sealed Power Flex-S Ring. Many tests have proved Sealed Power Flex-S superior to any other type of flexible oil ring.

Among its advantages are included better lubrication, less scuffing, greater oil economy, and longer ring life. THE EXCLUSIVE "S" DESIGN prevents buckling or wavering when compressed. It maintains true alignment. It is adaptable to an almost infinite range of unit pressure for specific installations. It is easily assembled on the piston, hugs the groove, can't fall away.

Because of its extreme flexibility and uniform radial pressure, Sealed Power Flex-S conforms perfectly to tapered and out-of-round bores. Flutter and vibration are eliminated. Metering of oil between all sectors provides vital lubrication all around the bore—no ring gap, no "wet" side, no "dry" side. Cylinder bore wear is definitely retarded. Perfect oil drainage removes all chance of clogging, carbon, or gum deposits.

Let us tell you the complete story!

Sealed Power Corporation

MUSKEGON, MICHIGAN

Great names in the Automotive Industry

HARRY C. STUTZ

Harry C. Stutz will ever be remembered as designer of the famous Stutz Bear-Cat, although his creative work for the automotive industry goes back many years beyond that. He first gained recognition in automobile circles with an improved rear axle, developed while working at Lindsay-Russell of Indianapolis.

Later Stutz helped introduce the Schebler carburetor to the trade, and his experimental work for G&J contributed much to the development of the modern automobile tire. His accomplishments also included the design for the American Underslung . . . the "road-huggingest" car of its day.

In 1911, a Stutz racer was one of the few to finish the 500-Mile Memorial Day race. This car became known as "the car that made good in a day" and was the basis of organization of the Stutz Motor Company, whose racers and sports cars are still fondly recalled.

(One in a series of sketches about great automotive industry pioneers. These have been compiled in book form and are now available on request.)

MONROE—THE GREAT NAME IN SHOCK ABSORBERS

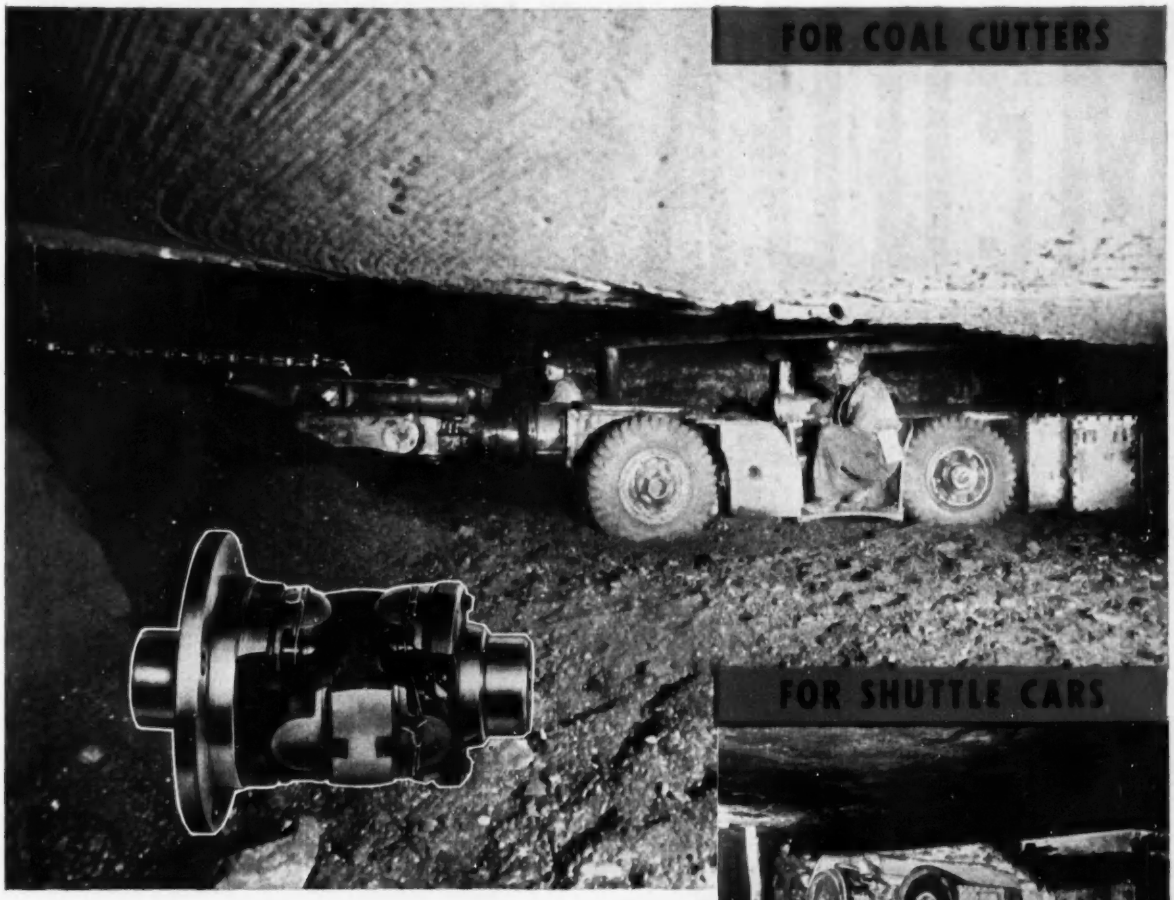
Together with better highways, improved ride control devices have greatly smoothed travel for America's autos, trucks and buses during the last half century. Monroe has pioneered in developing the best ride control products —shock absorbers, sway bars, struts and molded rubber parts. Today, Monroe ride control products are top choice among America's automotive engineers.

MONROE®

Monroe Shock Absorbers are standard equipment on more makes of new cars than any other brand of shock absorber.

MONROE AUTO EQUIPMENT CO.

Monroe, Mich.— World's Largest Maker of Ride Control Products



Heavy-Duty Mine Service Requires MECHANICS Quality

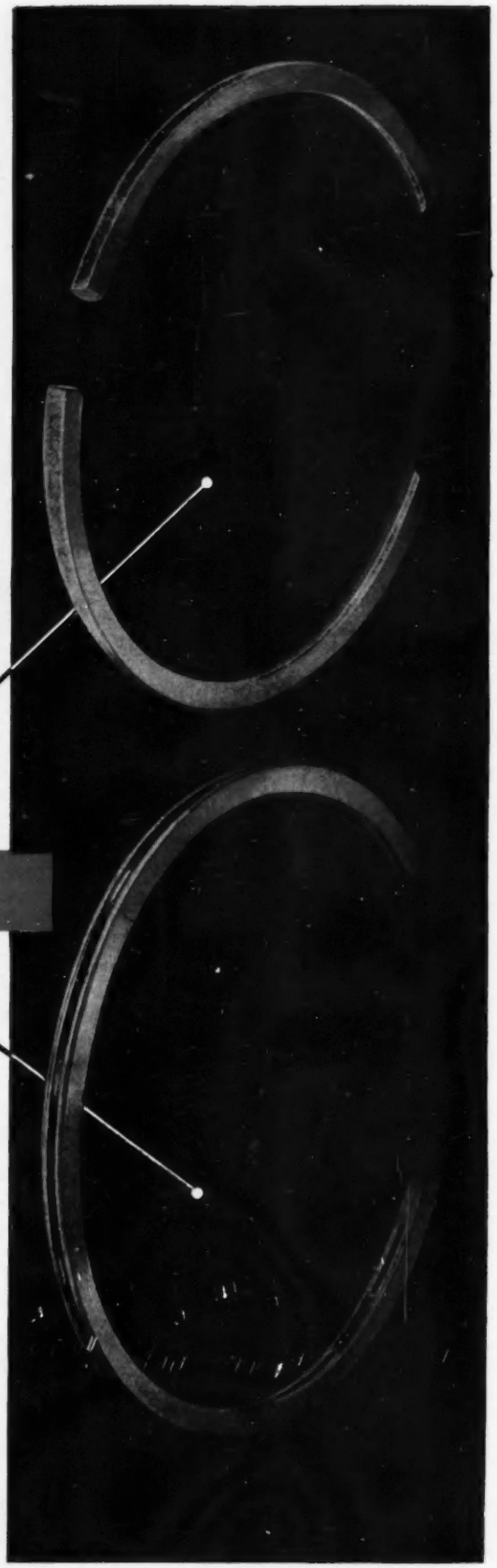
In cramped quarters — where starts, stops and reverses are frequent — loads heavy and torque requirements severe — amid dust and moisture — MECHANICS Close-Coupled, Roller Bearing UNIVERSAL JOINTS serve dependably, safely and economically. They perform equally well in other rugged machines where joint space is limited and angles are extreme. Let MECHANICS engineers help with *your* joint problems.

MECHANICS
UNIVERSAL JOINT
DIVISION
Borg-Warner
2020 Harrison Ave.
Rockford, Illinois

MECHANICS
Roller Bearing BW
UNIVERSAL JOINTS
For Cars • Trucks • Tractors • Farm Implements • Road Machinery • Aircraft • Tanks • Busses and Industrial Equipment

McQUAY-NORRIS

PISTON RINGS

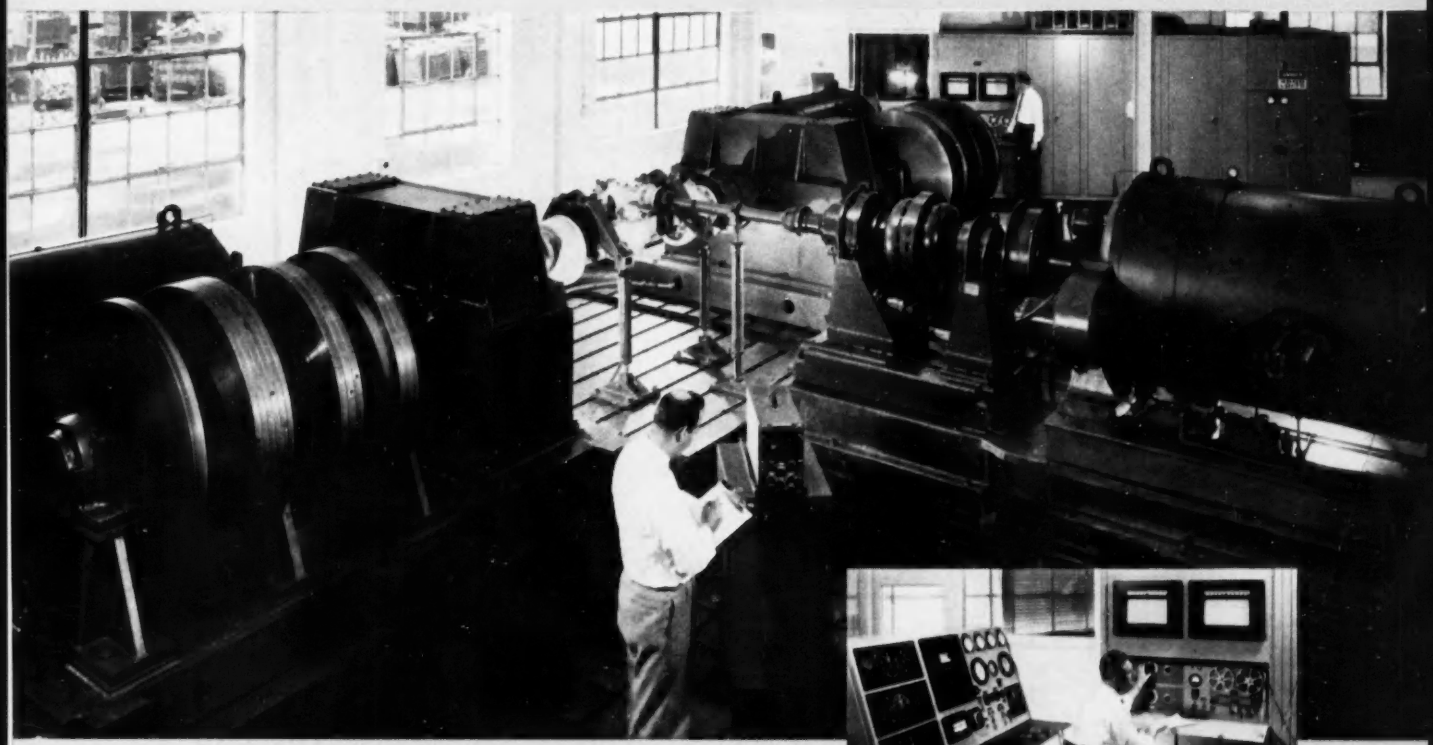


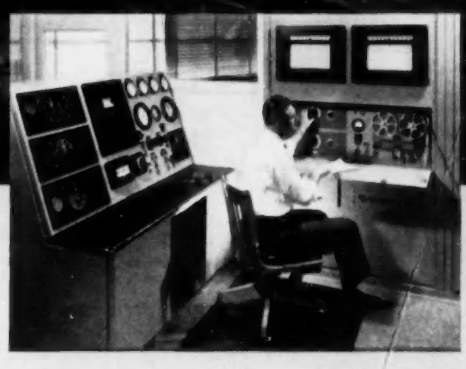
TIME TESTED
McQUAY NORRIS
PISTON RINGS
PROVEN IN SERVICE

Tried, and proved for over 40 years, the performance of McQuay-Norris piston rings is assured...and they are specifically engineered to meet every requirement, no matter how exacting.

McQUAY-NORRIS MANUFACTURING CO.
ST. LOUIS 10, MO.

New Indoor Proving Ground Helps **TDA** Build The Truck Axles of Tomorrow!





Shown at right is the automatic cycling control which repeatedly subjects the test axle to the same stresses it would receive when negotiating the grade and coasting conditions found in service.

● *A complete indoor proving ground!* That's what this new research laboratory at Timken-Detroit actually is! It enables TDA engineers to test heavy-duty truck axles while simulating the same conditions encountered in the toughest on- or off-highway operation.

Incorporating the largest, most modern dynamometer equipment for testing driving axles, this new laboratory can reproduce truck axle torques and speeds, with the ability to repeat these tests accurately time after time by means of an electronic automatic cycling control. Shock loading tests can also be run which, up to now, have been impractical to reproduce under driving load.

Every time you build or buy a truck with TDA Axles, *you* reap the benefit of Timken-Detroit's long experience and modern facilities. When you see the name TDA on an axle you *know* it's the best-engineered truck axle built!

PLANTS AT: Detroit and Jackson, Mich. • Oshkosh, Wis. • Utica, N. Y. • Ashtabula, Kenton and Newark, Ohio • New Castle, Pa.

The Accepted TDA Standard

AXLES

THE TIMKEN-DETROIT AXLE COMPANY
DETROIT 32, MICHIGAN

NEW TDA
Duplex Brakes

So Simple!

The new TDA Duplex *balanced* Brakes are the simplest brakes of their type ever designed. Except for a standard straight bore wheel cylinder, there are only eight different parts! Frequency of maintenance and adjustment is markedly reduced. What's more, when either is needed, you can accomplish the job simply, easily and rapidly.

So Effective!

TDA Duplex Brakes are *balanced* brakes! Two floating brake shoes with full-length lining contact the brake drum with *equal* pressure at every point. This eliminates high pressure contact areas—assuring quiet, positive operation at all times under all conditions. The Duplex Brake is equally effective in either forward or reverse directions.

WRITE TODAY FOR AN INFORMATIVE BOOKLET ON TDA DUPLEX BRAKES! IT'S FREE!

TDA Brake Division, Ashtabula, Ohio

Gentlemen:

Please send me immediately more information on your new Duplex Brake.

Name _____

Company _____ Title _____

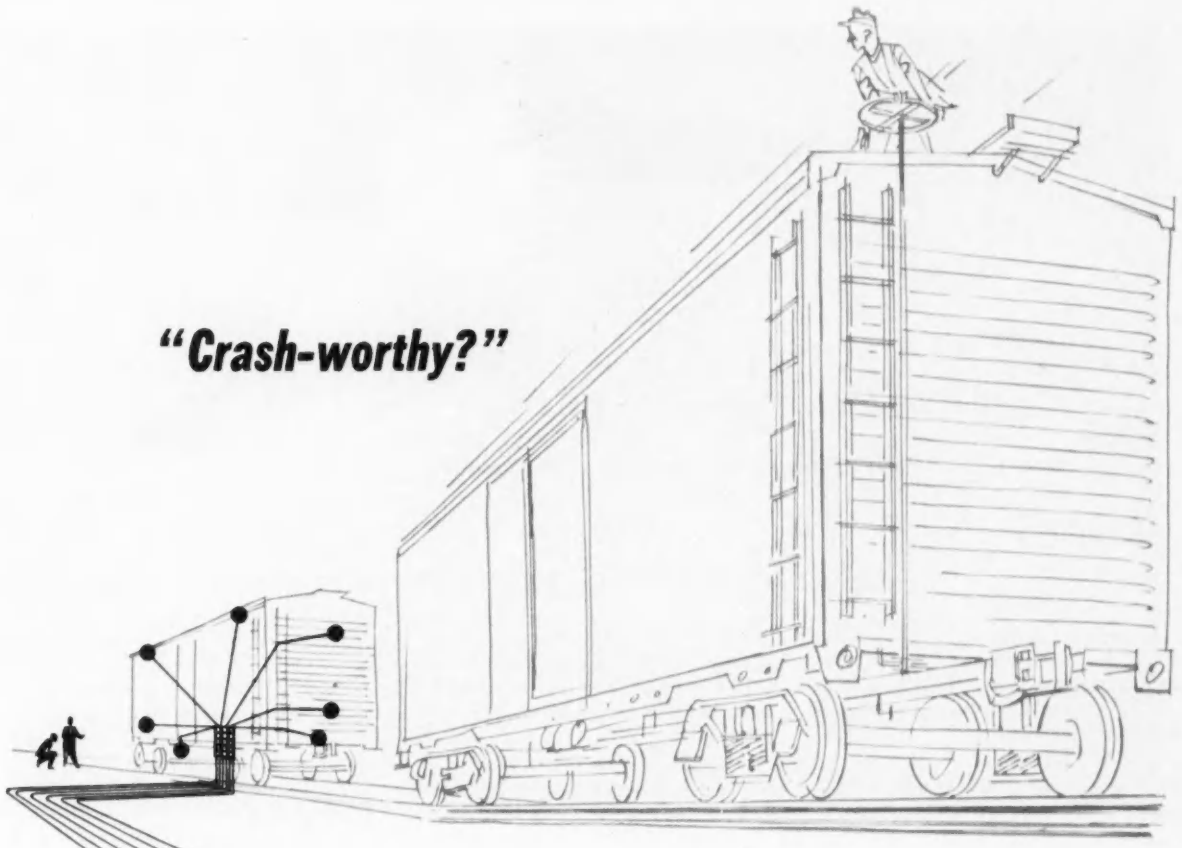
Address _____

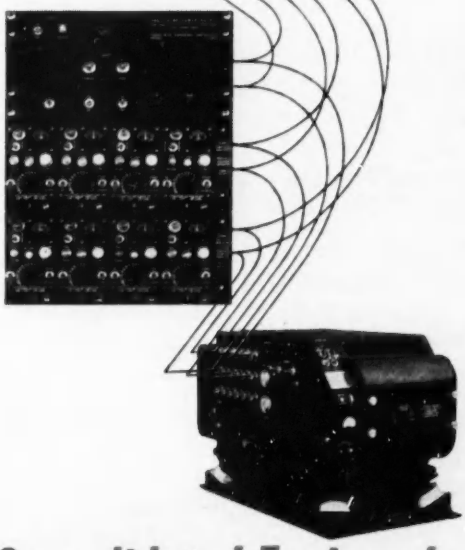
City _____ State _____

The Accepted TDA *Standard*

BRAKES

TDA BRAKE DIVISION
THE TIMKEN-DETROIT AXLE COMPANY
ASHTABULA, OHIO





Pre-check with Consolidated Instrumentation

WHAT happens to structural members and car-body components when freight cars are subjected to the shock impacts and buffeting of hump-yard switching?

To determine stress distribution and to evaluate the effectiveness of shock protection devices, the Pullman-Standard Car Manufacturing Company selected a Consolidated 5-114 Recording Oscillograph, System D Amplifiers, and Bridge Balance as basic recording instruments.

Freight cars, loaded with sand and steel blocks at gross weights ranging from 46,400 pounds (empty) to 164,000 pounds (fully loaded) crashed together 185 times at speeds up to 10 miles per hour.

In this way the dynamics of simultaneous shocks, some as brief as one five-thousandth of a second, were permanently recorded in visual form. From such data will come design changes, giving protection against shock and vibration damage. Thus an improved product is achieved.

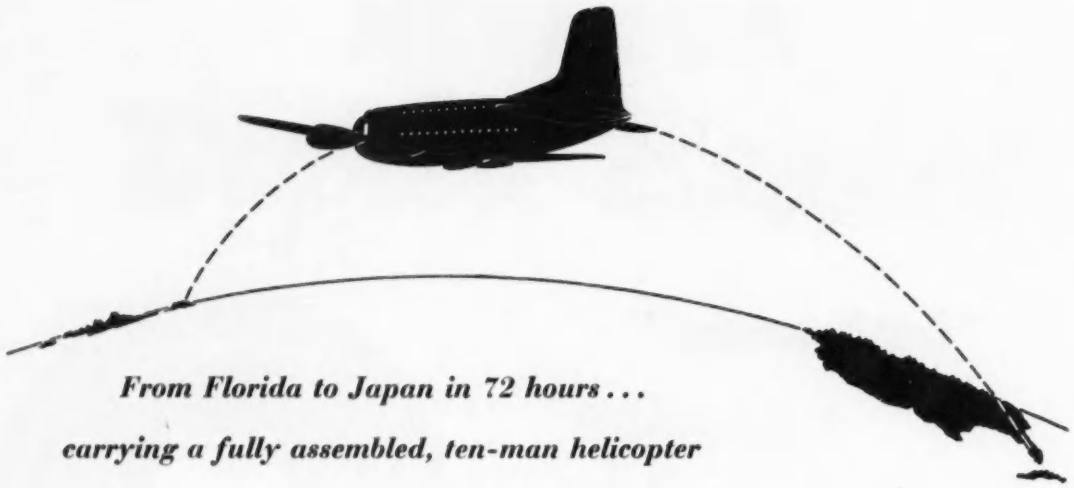
Consolidated Engineering
CORPORATION
300 North Sierra Madre Villa, Pasadena 15, California

Sales and Service through **CEC INSTRUMENTS, INC.,** *a subsidiary with offices in: Pasadena, New York, Chicago, Washington, D. C., Philadelphia, Dayton.*

analytical instruments for science and industry

Dynamic Recording Systems

such as the one shown here are designed and manufactured by Consolidated. Variations in the arrangement of the equipment are infinite. Applications are widely varied throughout industry and the sciences. A typical recording system includes pickups, amplifiers or bridge balances, and a recording oscillograph. Write for Bulletin CEC 1500B-X2



From Florida to Japan in 72 hours . . .

carrying a fully assembled, ten-man helicopter

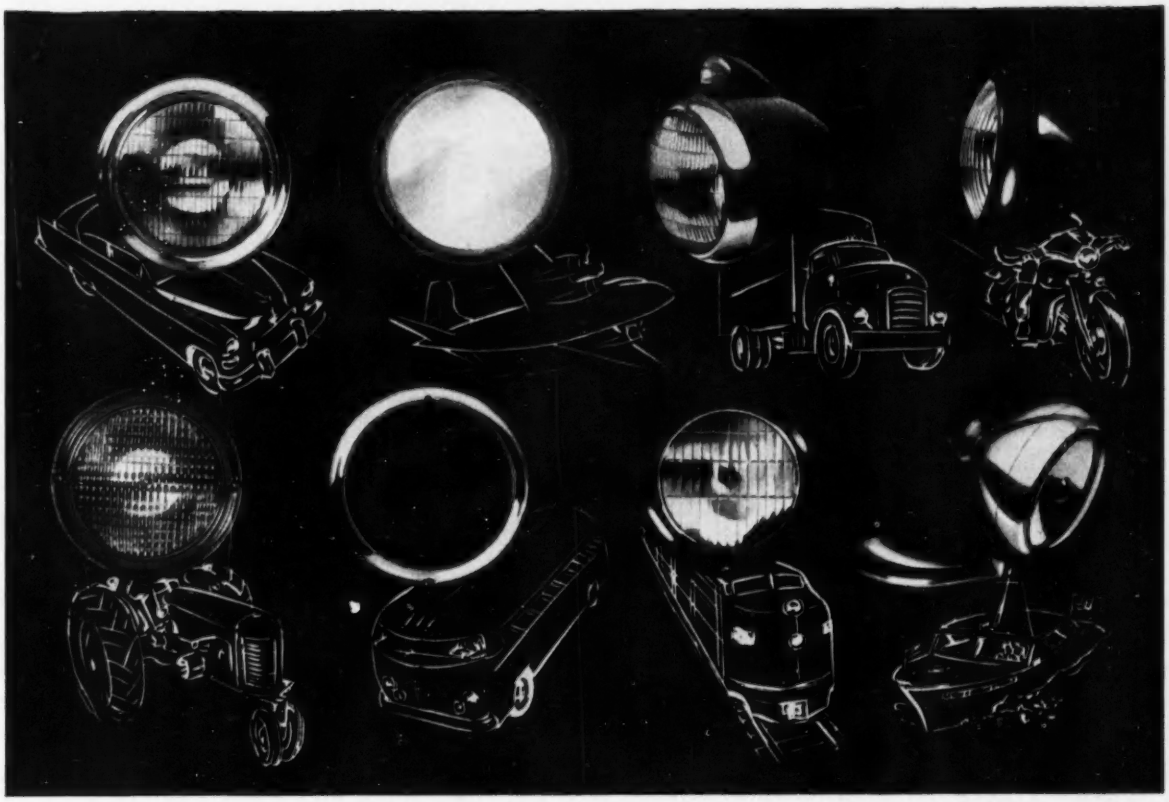
—the DOUGLAS C-124 Globemaster

From the front lines in Korea last year came calls for a 10-man helicopter. The Air Force had some, but they were in Florida—9,000 miles away.

Normal air transport could make the *flight* in time, but tearing down a helicopter—reassembling it in Korea—would waste a week. So the Air Force turned to a Douglas C-124 Globemaster, the flying giant that covers thousands of miles nonstop with a 25-ton payload. Globemaster opened its clam-shell doors and swallowed the helicopter whole, took off, and reached Japan in 72 hours. Next day, at the Korean front, our men had the helicopter they needed.

Performance of the Globemaster in action is another example of Douglas leadership in aviation. *Faster and farther with a greater payload* is a basic of all Douglas design.

Depend on *DOUGLAS* **First in Aviation**



Vision for Transportation

For each of the modern transportation miracles on land, on water and in the air, *vision* plays an important role. Engineers, designers and manufacturers are constantly studying the problems of vision . . . searching for ways it can be improved.

Since 1909, the C. M. HALL LAMP COMPANY has pioneered in America's lighting industry, and has contributed many major light-sight improvements. Today, with our subsidiary, INDIANA DIE CASTINGS, INC., we are supplying the many varied needs of civilian and military lighting. In our modern laboratories, we are at work developing better, more efficient lighting . . . striving to improve America's *Vision for Transportation.*

Bright-spot in the Transportation Center!

C. M. HALL Lamp Company

Vision for Transportation

1038 EAST HANCOCK AVENUE • DETROIT 7, MICHIGAN

and its wholly-owned subsidiary INDIANA DIE CASTINGS, INC. ELWOOD, INDIANA

There's a growing preference for ROLLWAY BEARINGS ...and with good reason!

Unwavering right-line rotation—free of skew, side-shock and end-rub—greatly extends the life expectancy of a Rollway Roller Bearing. Add to longer life the definite gains in smoother operation and lower maintenance costs and it's understandable why, today, demand for Rollways has reached a new peak.

Our increased facilities are expanding Rollway output as fast as possible. We are continuing to improve the balance between supply and demand, so that service to both established and new customers will be geared to their quantity requirements . . . another reason why bearing users can confidently specify "The bearings that *roll* right because they're *made* right."

Let's examine your bearing problems together. Our years of specialized experience, plus complete metallurgical services, are at your command. Just write or wire Rollway Bearing Co., Inc., Syracuse 4, N. Y.

RIGHT ANGLE
ROLLER ENDS, precisely square to avoid end-rub, oscillation and side-shock.

RIGHT ANGLE
BEARING SURFACES with parallelism that results in unwavering right-line rolling.

RIGHT ANGLE
SEPARATOR SLOTS accurately machined to prevent roller skew, slide and uneven wear.

SALES OFFICES

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ROLLWAY BEARINGS

Complete Line of Radial and Thrust Cylindrical Roller Bearings

The extra **BRAKING RUGGEDNESS** proven here...

...means

BIGGER MAINTENANCE SAVINGS

on any hauling job!

Why not take a tip for your braking specifications from the men who "roll-em" over the mountains out of Denver, on into California. Here, the rigs are big, the grades are steep—the **braking requirements call for the best . . .** and that means Bendix-Westinghouse Air Brakes! That's because these mighty brakes, built by the industry's most experienced manufacturer, deliver the extra stopping power and performance that assure the **safest, surest, most dependable braking control** and longest service life in the business. And these are factors that mean reliable, economical performance on any hauling job. That's why no matter what type trucks or buses you build, you can **give your customers increased efficiency, plus added savings on maintenance** and parts replacement costs by specifying the brakes proven for long, low-cost operation—Bendix-Westinghouse, the world's most tried and trusted air brakes!

BENDIX-WESTINGHOUSE AIR BRAKES

Bendix-Westinghouse AIR BRAKES

THE WORLD'S MOST TRIED AND TRUSTED

BENDIX-WESTINGHOUSE AUTOMOTIVE AIR BRAKE COMPANY • ELYRIA, OHIO • BERKELEY, CALIF.

New DELCO-REMY *Alternating Current*

GENERATORS

(ALTERNATORS)

A.C.-D.C. charging systems for vehicles with extra-heavy electrical loads

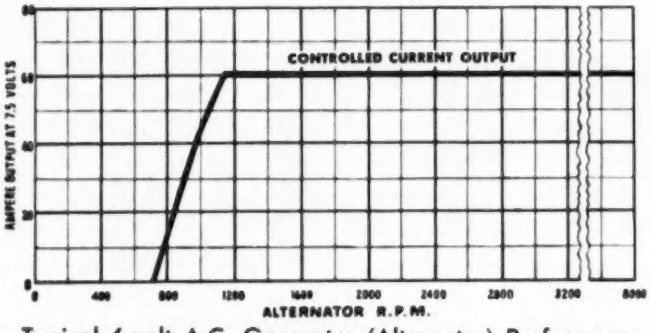
The new Delco-Remy 6-volt A.C.-D.C. electrical systems were designed specifically to handle the extra-heavy electrical loads on cars and trucks equipped with two-way radio, floodlights or other special units. Vehicles in this classification include taxicabs, police cars, ambulances, doctors' cars, and trucks in various public utility services.

With output capacity ranging from 30-40 amperes at curb idling to 90 amperes at higher engine-speeds, the A.C.-D.C. system shown has ample capacity to meet the heaviest requirements of 6-volt automotive applications.

Included in the new system is a special regulator for voltage control under all conditions. Where regulation of both current and voltage is necessary —because of the application requirement or state laws—regulators controlling both current and voltage can be supplied. With these regulators, the maximum current output is held to 60 amperes.

A rugged, dependable, dry-plate rectifier which changes the A.C. generator output to direct current, is also part of the system.

Other Delco-Remy A.C. generators are available in both 6- and 12-volt models in capacities up to 150 amperes.



Typical 6-volt A.C. Generator (Alternator) Performance Curve with Current Regulation

DELCO-REMY

Division, General Motors Corporation
Anderson, Indiana

AUTOMOTIVE, TRACTOR AND MARINE ELECTRICAL EQUIPMENT

As Time Goes By . . .

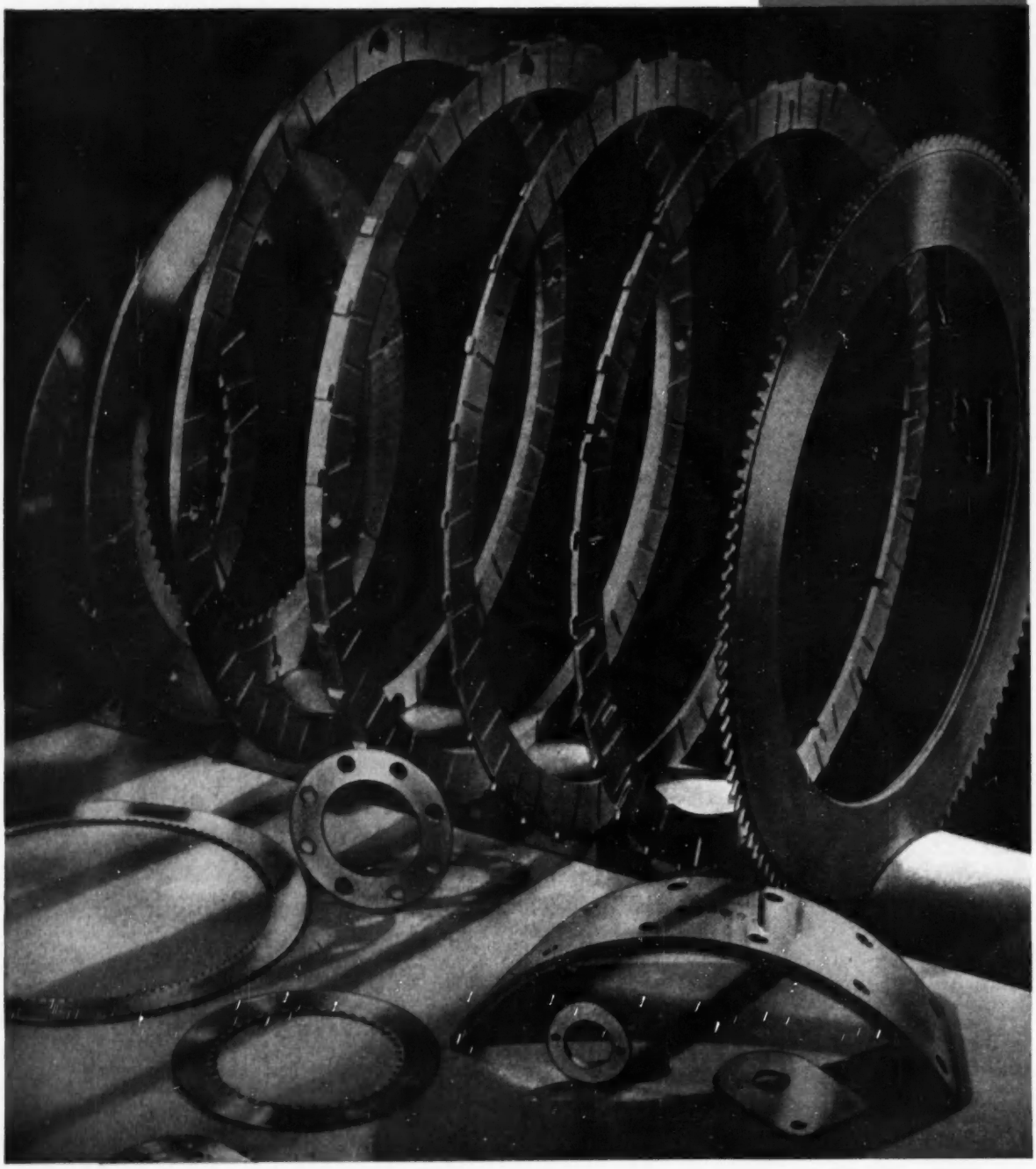
. . . "DETROIT" Sets the Pace for Universal Joints

America's leading cars—thoroughbreds of the road—have come a long way since the first "one-lunger". During this progress, the continual step-up of engine power has increased tremendously the burdens placed on universal joints. Improvements in "DETROIT" Universal Joints have kept pace with car and truck design to help America's vehicle manufacturers achieve products of vision and initiative.

DETROIT
UNIVERSAL JOINTS

UNIVERSAL PRODUCTS COMPANY, Inc., Dearborn, Michigan

RM
FIRST IN FRICTION



Sintered Metal Products

TO SOLVE YOUR SPECIAL FRICTION PROBLEMS

In an industrial era when controlled friction plays so important a part in "stop-and-go" operations, research in friction materials is essential.

New developments in the use of time-honored asbestos materials are part of the picture. So are developments in newer fields, such as that of powdered metallurgy.

In the automotive, aviation and earth-moving industries, sintered metal friction parts developed by Raybestos-Manhattan are operating with a high degree of performance and durability. Sintered metal performs well, for example, at extreme temperatures resulting from design requirements. How about *your* friction problems? Can we help?

Your R/M representative is a good man to know. He can work from samples, from designs on paper, or from figures on horsepower developed –combined with desired performance characteristics. With him you get the advantages offered by the world's largest maker of friction materials . . . with six great plants, their research departments, and their testing laboratories.

Woven and molded *asbestos parts are also included in R/M's complete line of friction materials . . . in the form of blocks, segments, discs, cones, collars and many special shapes.*

Write for our engineering bulletin outlining recent developments in friction materials for brake linings, clutch facings, and special shapes and sizes.

RAYBESTOS-MANHATTAN, INC.

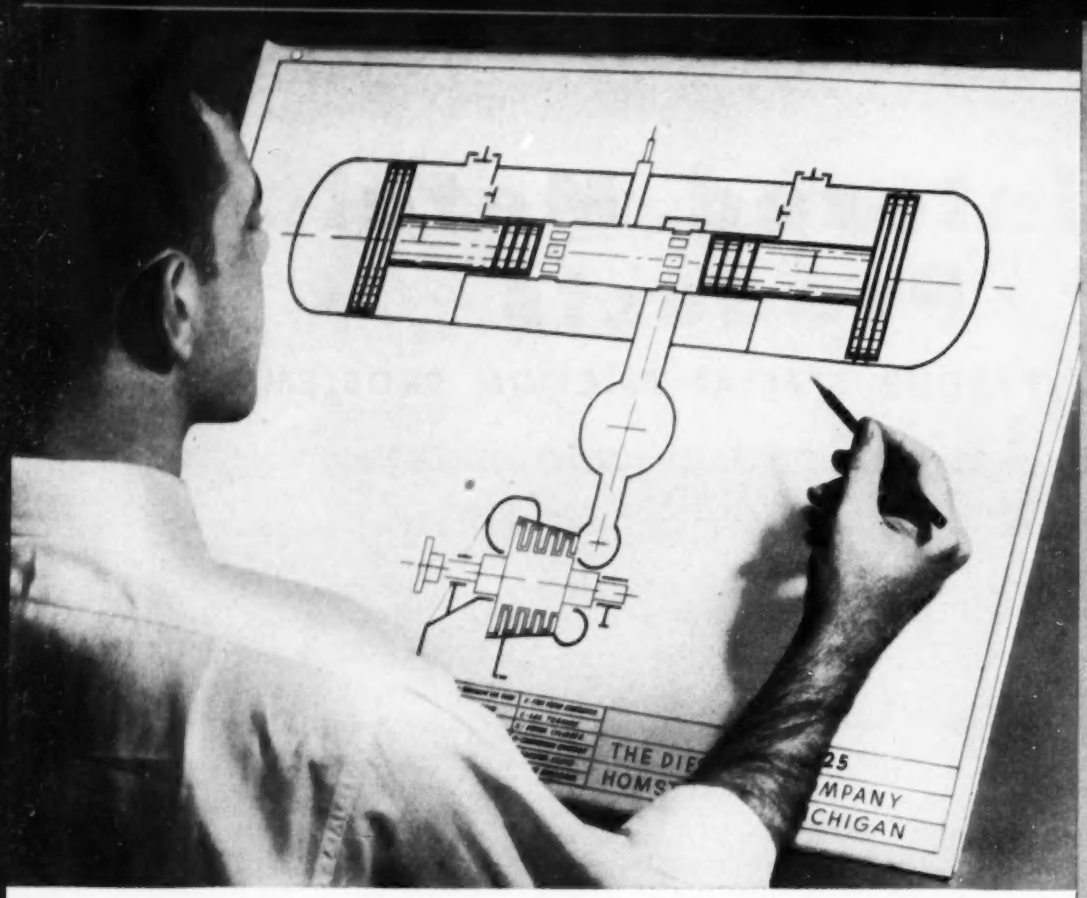
EQUIPMENT SALES DIVISION: 445 Lake Shore Drive, Chicago 11, Ill.

Detroit 2 Cleveland 14 Los Angeles 11

Factories: Bridgeport, Conn. Manheim, Pa. Passaic, N.J. No. Charleston, S.C.
Crawfordsville, Ind. Canadian Raybestos Co. Ltd., Peterborough, Ont.

RAYBESTOS-MANHATTAN, INC., Manufacturers of Sintered Metal Products • Brake Linings • Brake Blocks Clutch Facings • Fan Belts • Radiator Hose • Mechanical Rubber Products • Rubber Covered Equipment Asbestos Textiles • Teflon Products • Packings • Abrasive and Diamond Wheels • Bowling Balls

R M
FIRST IN FRICTION



Your new engine?

Use OHIO's service, and incorporate all the economies . . . machining and engineering . . . at the start . . .

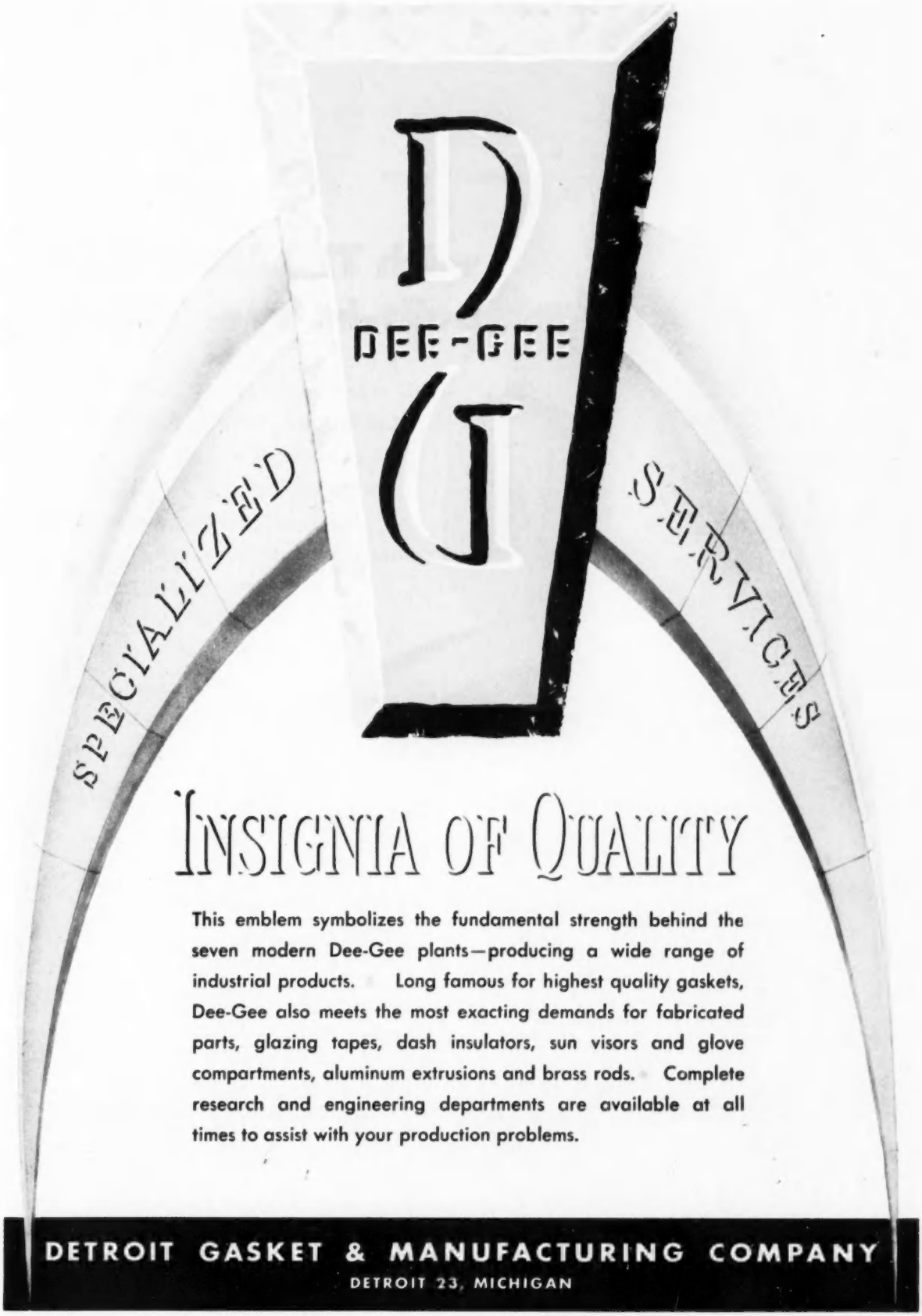
OHIO offers you an extraordinary PISTON service. Help in developing designs to meet the tougher conditions imposed by tomorrow's engines—then help in taking those designs out of the laboratory and putting them into production; OHIO PISTON service is that complete.

Available to you, through OHIO, are the best facilities of the country's leading piston casting producer. Their engineers and ours will work with you to turn theoretical pistons into real ones. You will get the best in engineering—and the lowest machining cost—in one package.

While your new engine is still on the drawing board, tell us what you expect of its pistons. Then piston performance and production will be proved well ahead of time for your assembly line. For this help, get in touch with The Ohio Piston Company, 5340 Hamilton Avenue, Cleveland 14, Ohio.

Aluminum Pistons
Cast Iron Pistons
Piston Pins
Cylinder Sleeves
Sleeve Assemblies
Oil Seals, Caps, Guides
Related Parts

THE OHIO PISTON COMPANY
Cleveland, Ohio



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This emblem symbolizes the fundamental strength behind the seven modern Dee-Gee plants—producing a wide range of industrial products. Long famous for highest quality gaskets, Dee-Gee also meets the most exacting demands for fabricated parts, glazing tapes, dash insulators, sun visors and glove compartments, aluminum extrusions and brass rods. Complete research and engineering departments are available at all times to assist with your production problems.

DETROIT GASKET & MANUFACTURING COMPANY
DETROIT 23, MICHIGAN

tiny to
giant-sized bearings

with TEAM-WORK built-in every size

With every size in SKF's wide range of ball and roller bearings, you receive an extra quality—*team-work*. This is the ability of SKF field and home office engineers to cooperate productively with your equipment designers. Helping to solve their bearing problems is the *extra* which all industries have learned to expect from SKF.

SKF
BALL AND ROLLER BEARINGS

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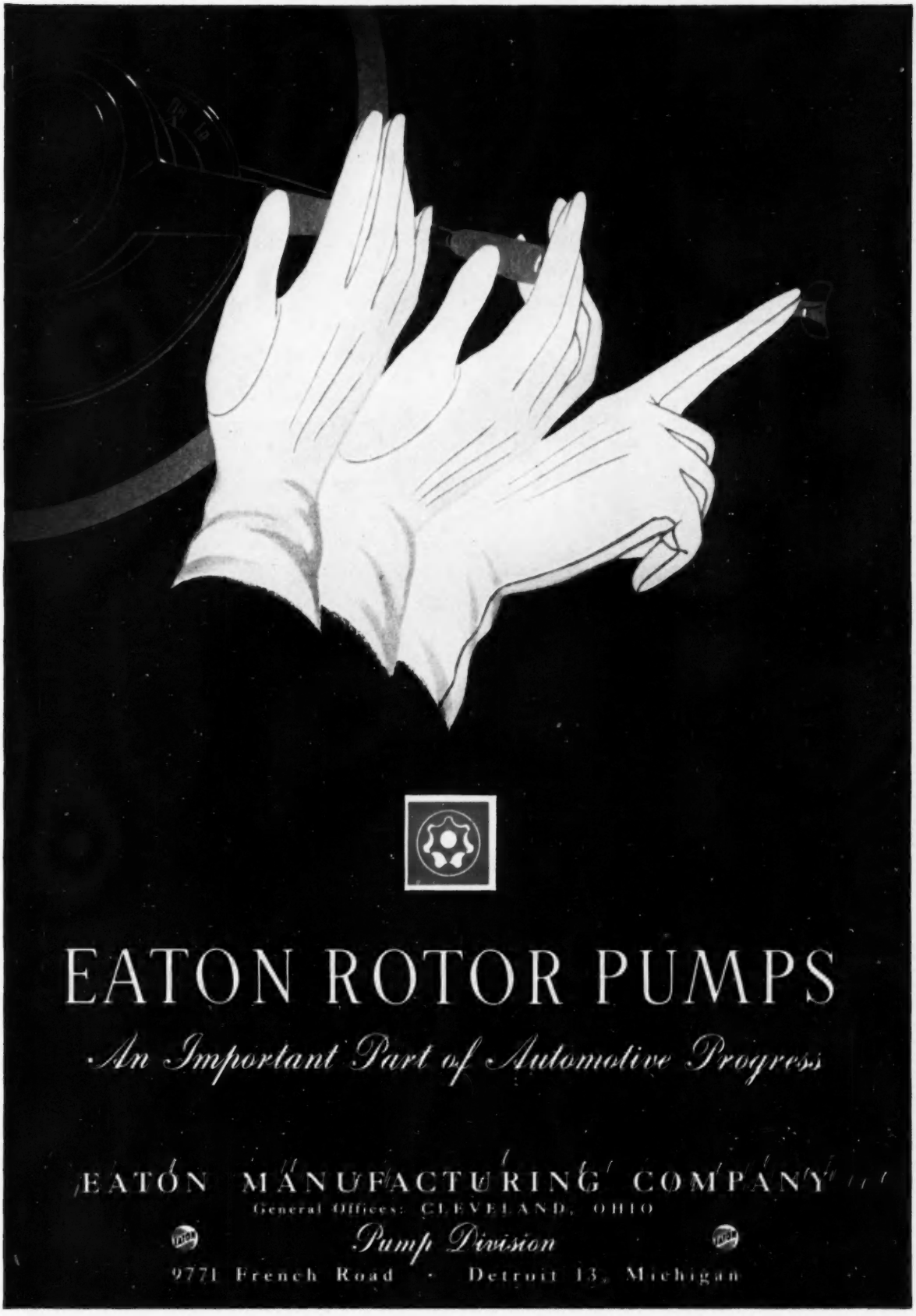
SKF INDUSTRIES, INC., PHILA. 32, PA.— *manufacturers of* SKF *and* HESS-BRIGHT *bearings.*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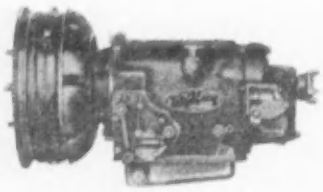
An Important Part of Automotive Progress
EATON MANUFACTURING COMPANY
General Offices: CLEVELAND, OHIO
Pump Division
9771 French Road · Detroit 13, Michigan



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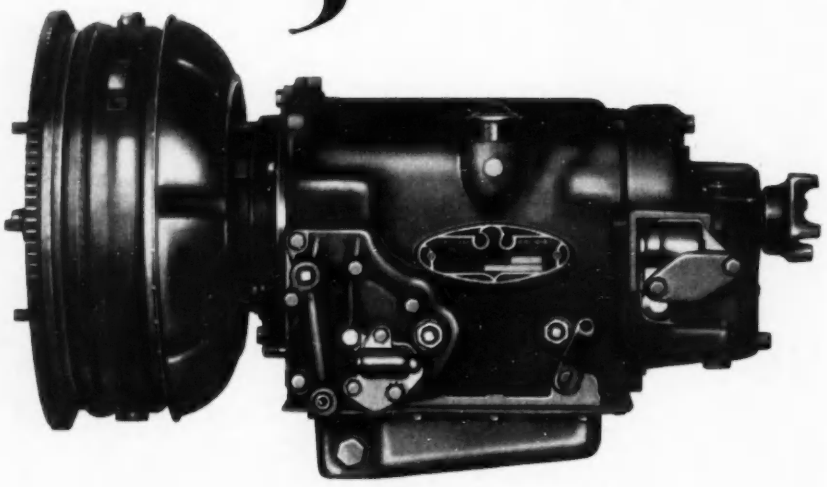
MAXIMUM EFFICIENCY

TOP DEPENDABILITY



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- **Fast acceleration from standing start—with full utilization of engine power.**
- **Smooth performance in all speed ranges.**
- **Solid direct drive in high—no slippage.**
- **Exceptional rocking ability in snow, mud, slush or sand.**

OTHER PRODUCTS BY DETROIT GEAR: TRUCK, TRACTOR AND BUS TRANSMISSIONS • TRACTOR AXLES AND HYDRAULIC PUMPS • GEARS AND PRECISION PARTS FOR CARS, TRUCKS AND TRACTORS

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Detroit Gear

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To forward looking engineers:

Lockheed in California offers you a better future...

in a better place to live

New design ideas that spring from spontaneous conferences such as these

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On the job, you work in an atmosphere of vigorous, progressive thinking. Personal initiative, new ideas are encouraged. Frequent conferences iron out problems, keep work rolling smoothly. You work with top men in your profession—as a member of the team known for leadership.

Outdoor life prevails in Southern California the year around

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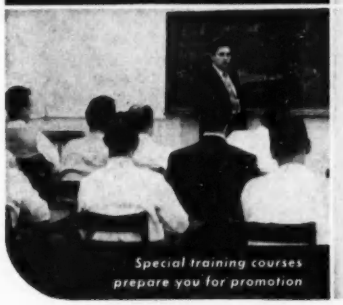
Every day, you get a "bonus" at Lockheed—in the better living conditions. The climate is beyond compare. Recreational opportunities are unlimited. Golf, fishing, the patio life at home can be yours 12 months a year. And your high Lockheed salary enables you to take full advantage of the climate and recreational opportunities.



Special training courses prepare you for promotion

Better Future

You have a *future* at Lockheed—not just a job. For Lockheed is building planes for defense, planes for the world's airlines. The planes of tomorrow are being designed today in Lockheed's long-range development program.

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Lockheed also offers you: *Generous Travel allowances • Outstanding Retirement Plan • Vacations with pay • Low cost group life, health, accident insurance • Sick Leave with pay • Credit Union, for savings and low-cost financing • Employees' Recreation Clubs • Regular performance reviews, to give you every opportunity for promotion • On-the-job training or special courses of instruction when needed.*

IMMEDIATE OPENINGS FOR:

Autopilot Engineers – With at least five years' experience in autopilot design and development. This includes experience with electrical and electronic networks as well as mechanical and hydraulic design problems that occur in present-day autopilots. You should also be familiar with servo analysis and synthesis procedures, utilizing analog computers, flight simulator tables, etc.

Ballistics Engineers – Experienced in theoretical ballistics, calculations of trajectories, flight control systems and in the application of higher mathematics.

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Engineering Technical Writers

Flight Manual Engineers

Machine and Equipment Design Engineers

Manufacturing Engineers

Mathematical Numerical Analysts–With a degree in mathematics or physics plus a minimum of one year's experience in mathematical numerical analysis. Your work will involve programming for IBM type 604, CPC, and stored program calculators.

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Servo Engineers–With at least three years' experience in servo analysis, a working knowledge of differential equations, operational calculus, Laplace transforms, etc.

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Aircraft experience is *not* necessary for a job at Lockheed. It's your general engineering background—your aptitude—that counts. Lockheed will train you to be an aircraft engineer—*at full pay.*

a proven steel

FOR GAS TURBINE STRUCTURES

N-A-X

AC9115 ALLOY STEEL

The production of gas turbines for jet aircraft engines and other uses is dependent upon metals which at both high and low temperatures have good strength, toughness, and stability before and after welding. N-A-X AC9115 ALLOY STEEL possesses these properties and is applicable to those parts where the operating temperatures range from $-70°$ F. up to about $+1000°$ F., and where suitable coatings are used for surface protection against normal and hot corrosion.

N-A-X AC9115 ALLOY STEEL has outstanding cold forming and welding characteristics and conserves critical alloys in its composition.

For more information about N-A-X AC9115 ALLOY STEEL, send for our new booklet.

A New Booklet For Design Engineers

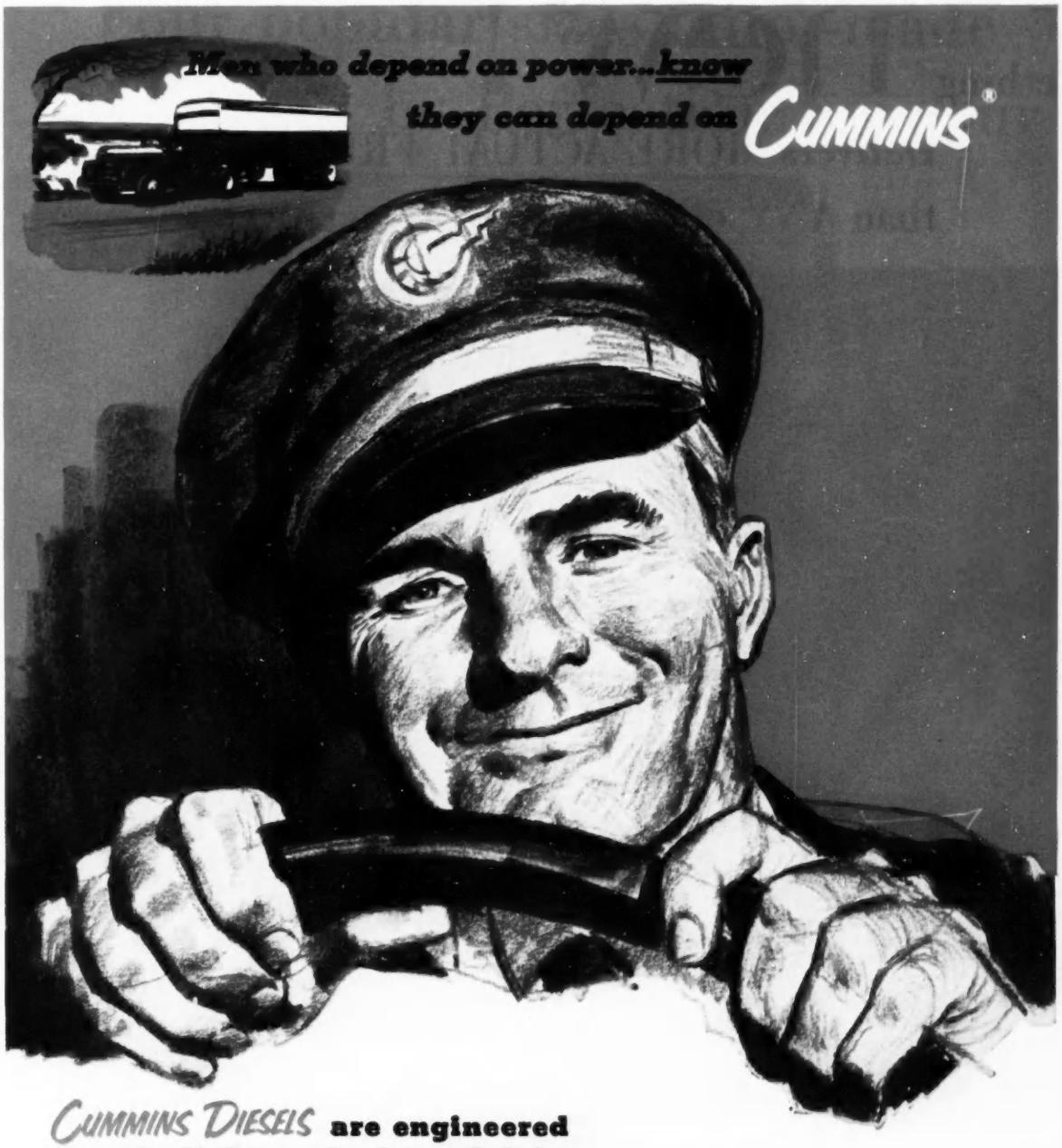
Write for this 16-page booklet on N-A-X AC9115 ALLOY STEEL. It describes the properties and characteristics of this material and offers information on its fabricating and welding properties.

GREAT LAKES STEEL CORPORATION

Alloy Division — Ecorse, Detroit 29, Michigan

NATIONAL STEEL CORPORATION

Makers of the famous NAX



CUMMINS DIESELS are engineered to make light work of tough jobs

Progressive, eyes-ahead engineering is one of the big reasons why so many truckers pick Cummins Diesels for dependability.

Consider Cummins' exclusive system of fuel injection and metering—an important factor in the unequalled performance records established by lightweight, high-speed (60-600 h.p.) Cummins Diesels. No other Diesel fuel system is *so simple . . . so rugged!* It delivers a uniform, properly prepared fuel charge to every cylinder. All under low pressure.

Your Cummins dealer will be glad to tell you about the many engineering advantages built into every Cummins Diesel. He is an expert who knows the requirements of your job. He heads up a specialized parts and service organization—equipped to handle all your diesel power needs. Call him today . . . or write!

***Leaders* in rugged, lightweight, high-speed diesel power!**

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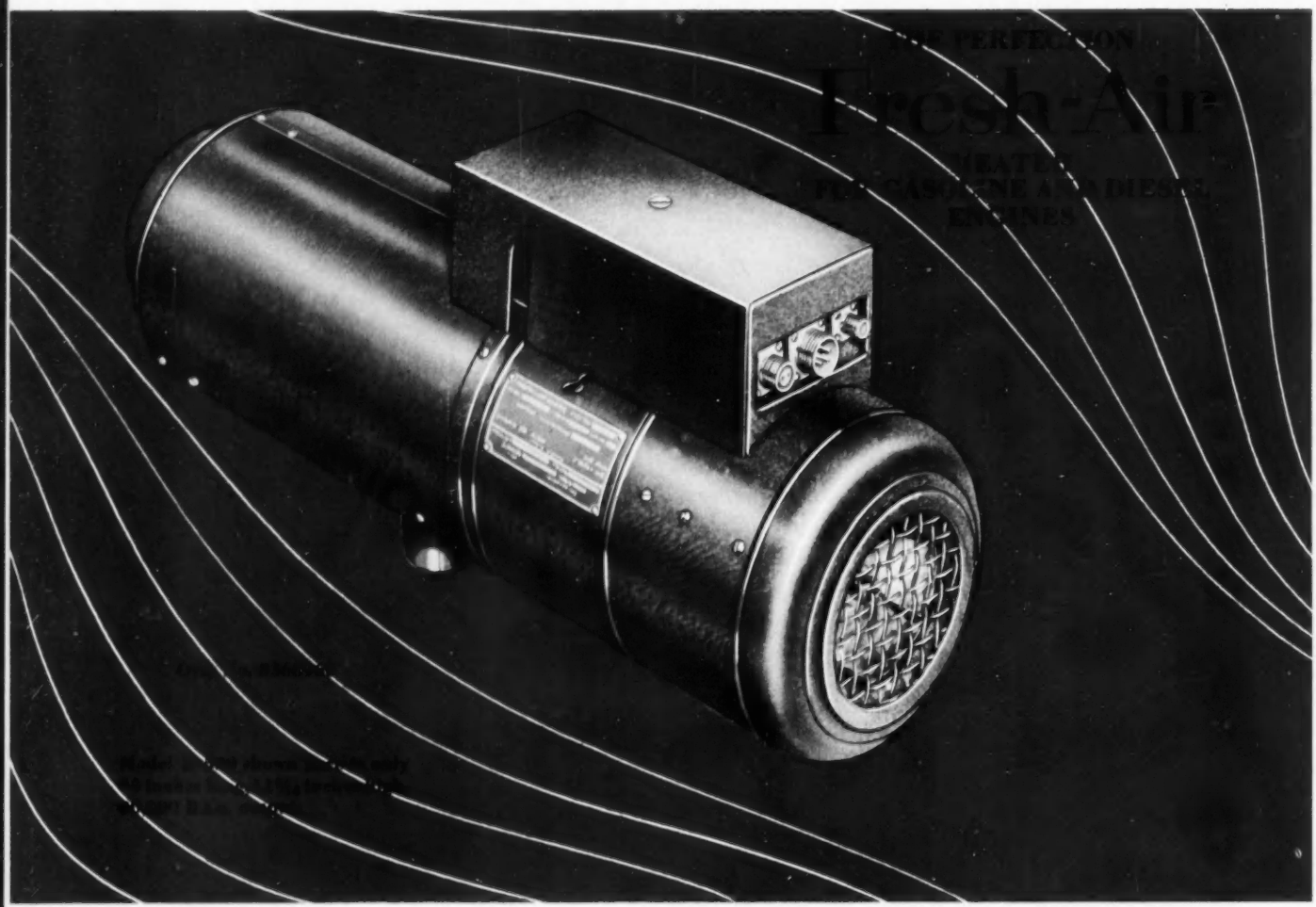
TRADEMARK REG. U.S. PAT. OFF. PENDING

CUMMINS ENGINE COMPANY, INC., Columbus, Ind. • *Export:* Cummins Diesel Export Corp., Columbus, Ind., U.S.A. • Cable: CUMDIESEL

Something new!

Delivers MORE ACTUAL FRESH-AIR HEAT than ANY other unit of this type!



EVEN AT 70° BELOW THE NEW PERFECTION DOES 4 BIG JOBS!

Provides *Real* Comfort for Personnel! Keeps them warm no matter how cold the weather outside.

Keeps* Windshields Clear — *Always! Guarantees proper vision by quickly disposing of ice, snow and fogging.

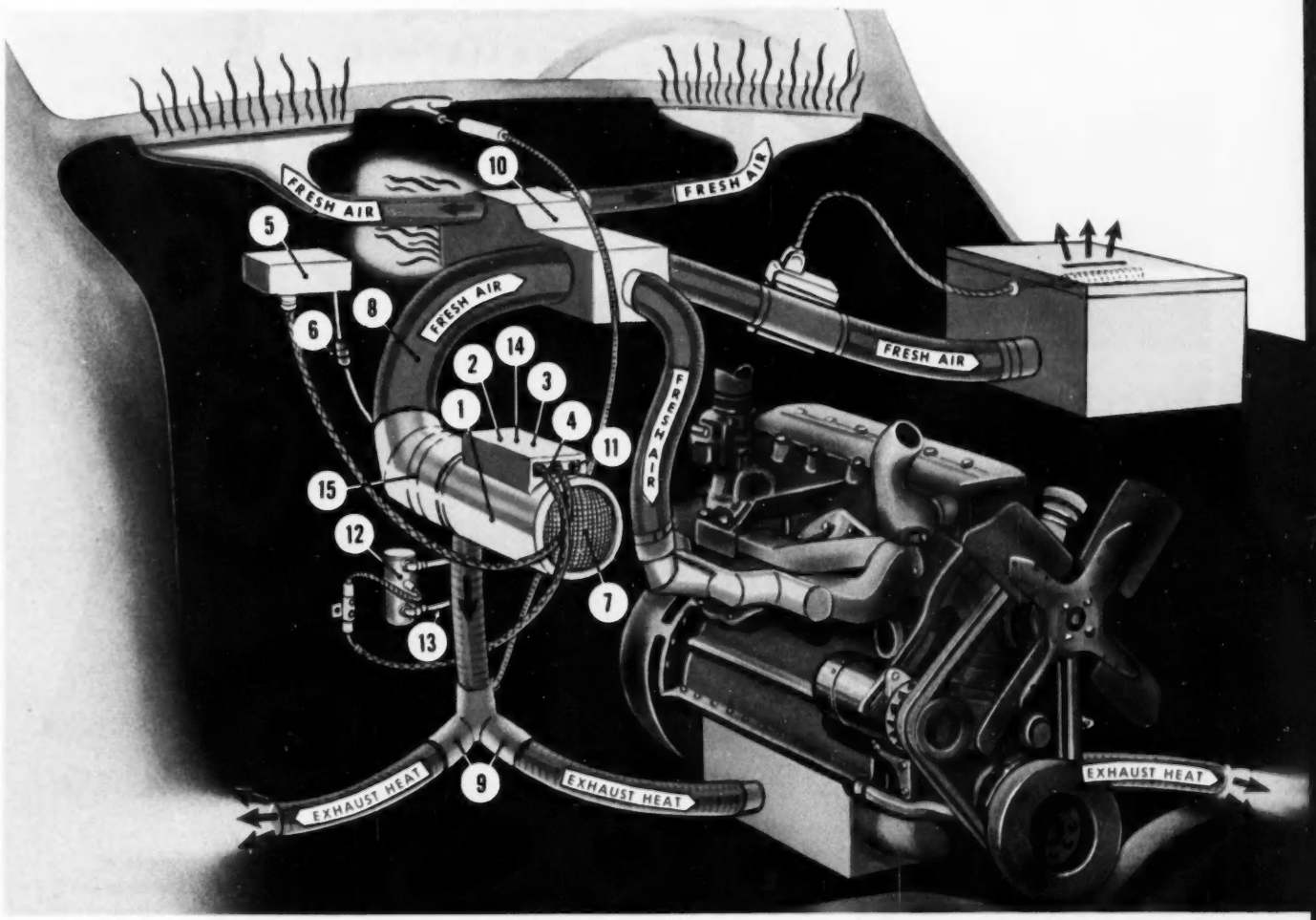
Safeguards Cargoes *in Coldest* Weather! Even at temperatures of 70° below, perishable cargoes can be protected.

***Preheats* Gasoline and Diesel Engines!** Assures quick, easy starting. Prolongs engine life. Eliminates costly "freeze-ups".

PERFECTION STOVE CO. • 7391-A PLATT AVE. • CLEVELAND 4, OHIO

Perfection

Four popular sizes tailor-made by Perfection for your job!



1. Compact Tubular Heater Design—EXTRA strength, LONGER life and HIGHER efficiency because of tubular design and finned heat exchanger.

2. Easiest to install and service—Blower, burner, heat exchanger and ALL safety controls built into ONE unit. Compact! 20,000 B.t.u. size weighs only 20 lbs.; 30,000 B.t.u. size—23 lbs.; 60,000 B.t.u. size—28 lbs.; 90,000 B.t.u. size—36 lbs. Can be mounted in ANY position. Operates independently of vehicle engine.

3. Non-Clog Fuel-Metering Jet—This Perfection EXCLUSIVE maintains a steady flow of fuel regardless of temperature changes.

4. Positive Electric Starting—Dependable Perfection Glow Plug provides positive ignition. Perfection Fuel Timer shuts off fuel supply, eliminates flooding in case of fuel or battery failure.

5. Remote Control—ONE switch, mounted where *you* want it. Manual, semi-automatic or fully-automatic operation.

6. ONE connection ONLY to Power Source.

7. Exclusive Blower Design—Unique blower delivers *more* heat through *longer* duct lengths without the aid of an additional fan.

8. Maximum Heat—Tubular design, dual heat-exchanging chamber, finned construction deliver maximum heat with minimum power and space requirements.

9. Extra Heat When Needed—Additional heat for heating oil pan, transmission or batteries available from the heater's exhaust.

10. High Pressure Distribution—Positive delivery of fresh, heated air to *all* points from a single heater.

11. Thermostat Connection—Provides for semi-automatic or fully-automatic operation.

12. Fuel Pump—This pump means heater operates entirely independently of vehicle engine.

13. Single Connection to Existing Fuel Supply Tank.

14. Quality Built-in Fuel Filter.

15. Quality Construction Throughout.

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Fresh-Air Heaters

O-RINGS

Made of rubber. Self-sealing for single or double action. Excellent for pressures under 1500 psi. Applied with leather back-up rings, can be used with pressures over 1500 psi when engineered correctly. Installed in groove in rod gland or piston head; also used as a static seal.

G&K — INTERNATIONAL Packings Specialists,

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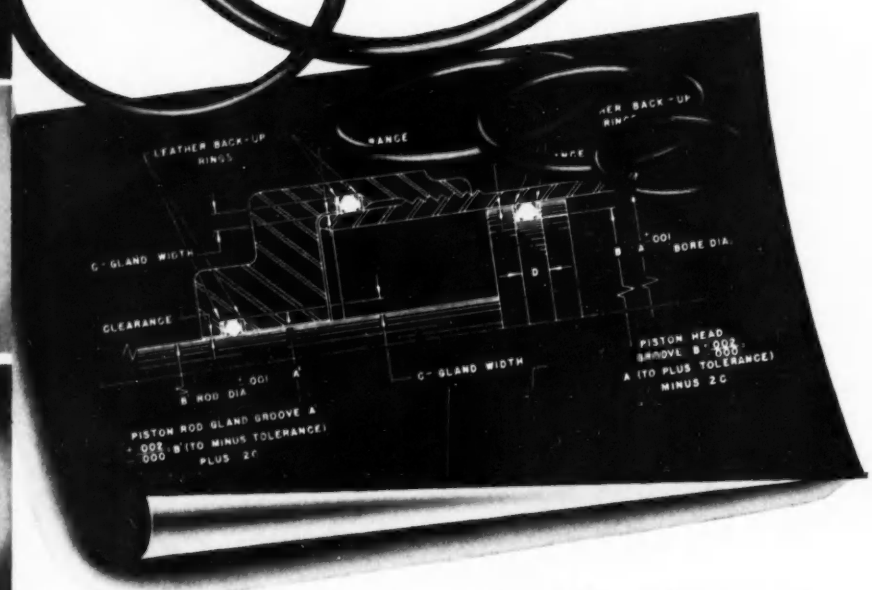

There's one *right* packing for each application . . . *and only one.* Because, in the packings business, there is no such thing as "just as good." It's a precision business where knowledge and experience count.

That's why you can be sure when you bring your packings specs to G&K-INTERNATIONAL, the packings specialists. One entire plant and personnel are devoted solely to the design, engineering and manufacture of leather and/or synthetic rubber packings.

All standard packings types of leather or synthetic rubber can be ordered to JIC Standards for Original Equipment or Replacement. For special jobs send details. You'll get prompt service.

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Up-to-date tables covering basic rubbers and approved compounds, dimensional data and installation detail. A right-hand reference manual for design engineers. Write for it now — it's free.

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Established 1851
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INTERNATIONAL PACKINGS CORPORATION
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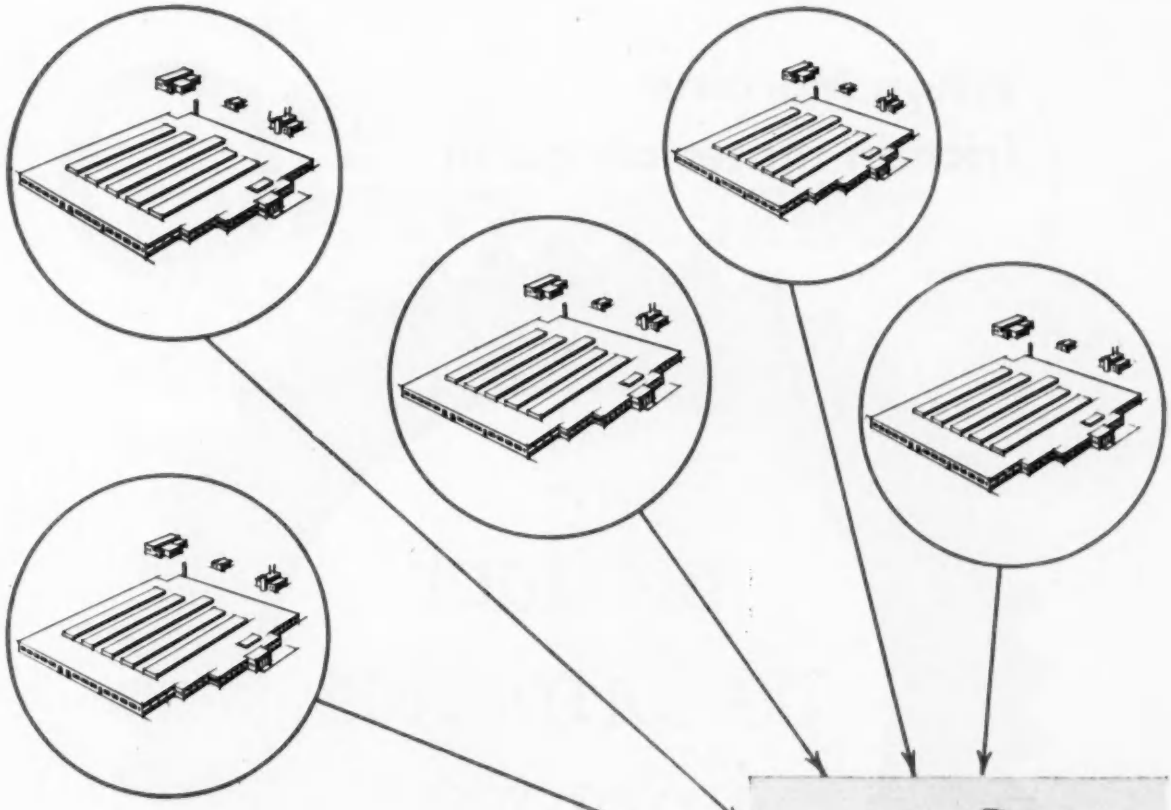
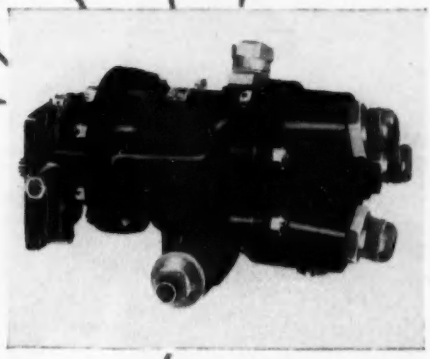


Expanded Production of *Pesco Fuel Pumps . . .*



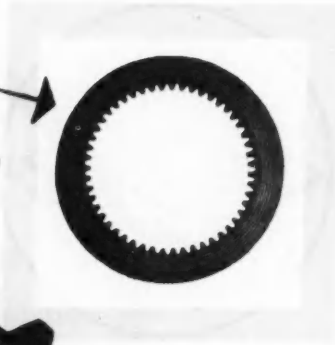
Today, five factories, in five cities, are devoting all, or part of their manufacturing facilities to building Pesco fuel pumps. The result is a three-fold increase in the production of these vital jet engine and aircraft parts.

In each of these five plants, Pesco's rigid statistical quality control, high standards of precision craftsmanship, and grueling production tests give complete assurance that these Pesco pumps will operate more efficiently and more safely over a longer period of time . . . will not fail when human lives are depending on them.

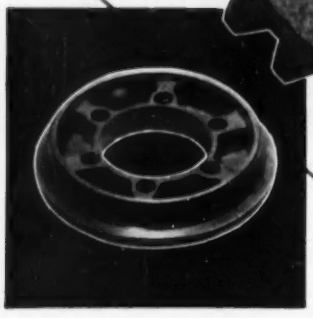
engineering Pesco PRODUCTS DIVISION production

Pesco Products Division, Borg-Warner Corporation, 24700 North Miles Road, Bedford, Ohio

When Moraine friction materials go in . . .



product performance improves



Moraine friction materials are well known for their efficient performance in automatic transmissions such as Hydra-Matic, Powerglide, and Dynaflow. They have additional applications in automotive and other fields that may lead to improved performance at less cost. These include special military equipment, household appliances, and automatic transmissions for commercial trucks of every size and military vehicles.

Having proved to industry our ability to mass-produce friction materials utilizing powder metallurgy and/or semi-metallic or non-metallic facings, we may be in a position to help you.

If you need substantial quantities of parts incorporating friction material facings, please feel free to contact us—at any time.

moraine products

DIVISION OF GENERAL MOTORS CORPORATION, DAYTON, OHIO

Thompson's CREATIVE CASTING OFFERS YOU BETTER PISTONS

Diesel Heavy-Duty Piston

Aircraft Piston

Tractor Piston

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OVER 50 YEARS of making precision parts for the automotive and aircraft industries . . . has given Thompson engineers opportunities to improve on many methods and materials.

"Creative Casting"—a Thompson development—makes possible the use of metals that withstand high temperature—that are strong—that are lightweight and can be cast to very close tolerances.

Whether it's a piston for an airplane, a passenger car, a heavy-duty truck or tractor engine—gasoline or diesel—you'll find that Thompson's Light Metals Division can make it better. Thompson's famous STEEL-BELTED PISTON is one example of a Thompson FIRST that gives better engine performance in cars, trucks, buses and tractors. Write or call and a competent representative will call to help you solve your piston problems.

Write on your company letterhead for a copy of this data book on Thompson's Steel-Belted Pistons.

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2269 Ashland Road • Cleveland 3, Ohio

RYAN

Aircraft and Aeronautical Products

Leaders in High-Temperature Metallurgy

for

JET, PISTON AND ROCKET ENGINES

One of the keys to Ryan's leadership in high-temperature metallurgy and ceramics is its modern equipment, including some of the finest high precision machine tools and many of the largest electric resistance welders to be found in the country today. Such equipment, combined with the skills of Ryan research and production engineers, has put Ryan out in front in solving the "hot" problems of the aircraft industry.

Typical of the precision machines found at Ryan is this 64-inch Bullard vertical turret lathe, largest on the Pacific Coast. Ryan uses it and scores of other modern tools for large-scale production of heat-resistant products for jet, piston or rocket engines. You'll find Ryan metallurgists and research specialists in the forefront of high-temperature development work.

Ryan SINCE 1922

Metal Products Division · Jet Engine Components · Exhaust Systems · Rocket Assemblies

RYAN AERONAUTICAL COMPANY • LINDBERGH FIELD • SAN DIEGO, CALIF.

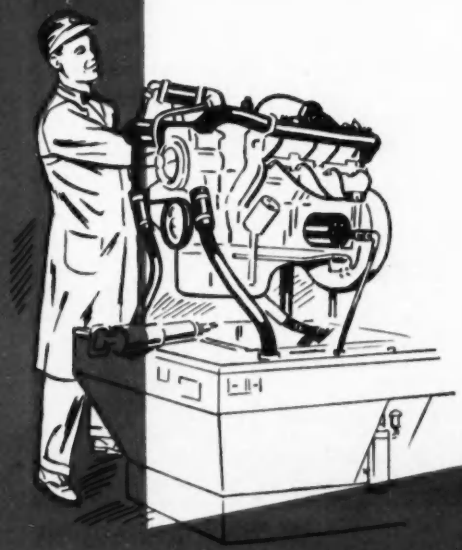
STERLING'S NEW
CONFORMATIC*
PISTON

THIS STEEL TENSION MEMBER
Maintains fitting clearance from —20° F. to 200° F.

Can Be Safely Fitted to .001 Clearance, or Less . . . Without Danger of Scuffing or Seizing

You get quieter engines, eliminate cold slap and reduce friction . . . without sacrificing piston strength or conductivity. No cold slap at temperatures as low as —20° F. . . . no seizing or scuffing at 200° F.

LOOK AT THESE TEST RESULTS . . .



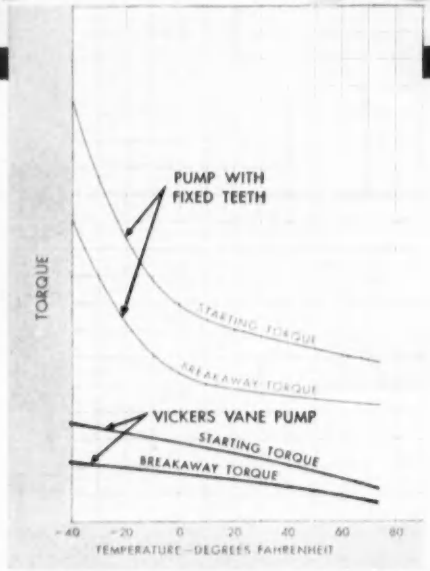
RESULTS OF 1200 Hour CYCLE TEST

In recent cycle tests made by one of the largest automotive manufacturers, Sterling *Conformatic* pistons were fitted into a stock engine at .0005 clearance. After operating the engine for 1200 hours, approximately half of that time at full load and full throttle, *the Conformatic Pistons were pronounced perfect.*

STERLING
PISTONS

*U. S. Pat. Off., Patent Applied for

STERLING ALUMINUM PRODUCTS, INC. • St. Louis, Missouri



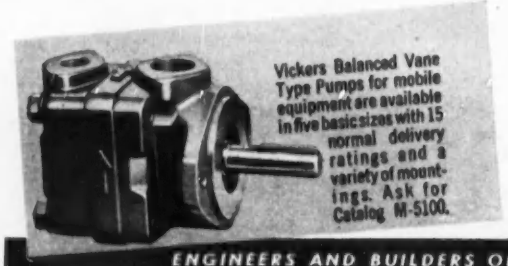
Curves based upon comparative tests of a Vickers Vane Type Pump and one with fixed teeth of equal capacity. Oil used complied with Army Spec. 2-79-B.

With VICKERS
BALANCED VANE TYPE PUMPS

Cold weather imposes a double handicap in starting. All engine parts tend to be stiffer, and the power of the starting battery is greatly diminished. In vehicles furnished with power hydraulic equipment, the starting load may be seriously increased when a pump with fixed teeth or lobes is directly connected to the engine.

Vickers Balanced Vane Type Pumps do not have this effect. At rest and at normal starting speeds, the sliding vanes are retracted . . . only after the engine fires do the vanes extend and pumping begins. The result is that Vickers Vane Type Pumps make cold weather starts much easier.

For further information, get in touch with the nearest Vickers office listed below.



Vickers Balanced Vane Type Pumps for mobile equipment are available in five basic sizes with 15 normal delivery ratings and a variety of mountings. Ask for Catalog M-5100.

VICKERS Incorporated
DIVISION OF THE SPERRY CORPORATION
1440 OAKMAN BLVD. • DETROIT 32, MICH.

Application Engineering Offices: ATLANTA • CHICAGO (Metropolitan) • CINCINNATI • CLEVELAND • DETROIT • HOUSTON LOS ANGELES (Metropolitan) • NEW YORK (Metropolitan) • PHILADELPHIA • PITTSBURGH • ROCHESTER • ROCKFORD • ST. LOUIS SEATTLE • TULSA • WASHINGTON • WORCESTER

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Ask for New Catalog M-5100

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THE MOST Trouble-free
IGNITION CONDENSER
EVER DESIGNED • • •
At low Cost too !
Let us design the condenser for your product or, we will make it to your specifications —
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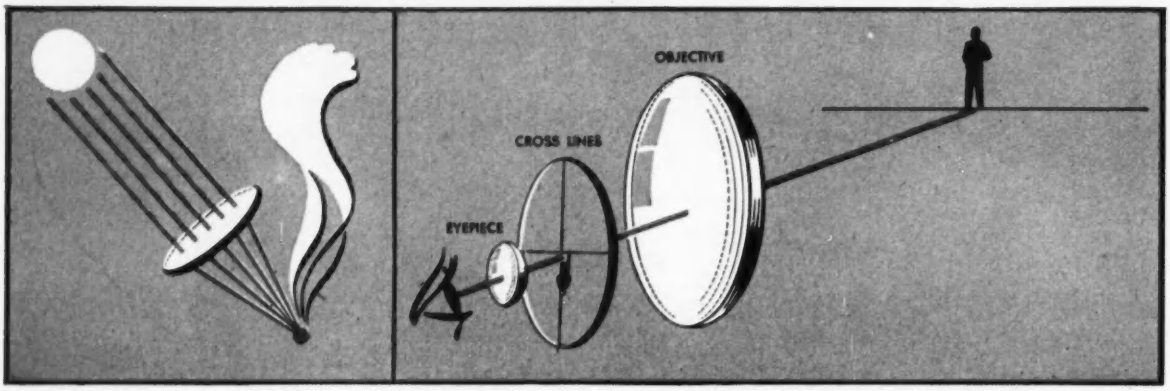
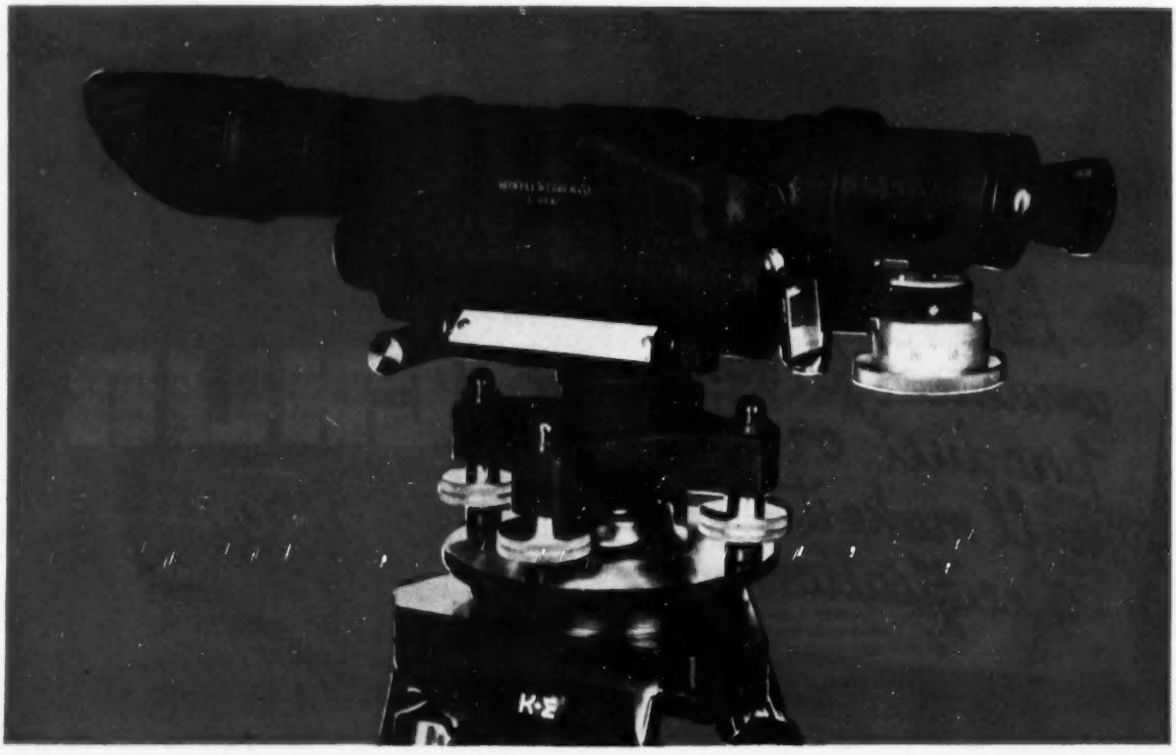
ECHLIN MANUFACTURING COMPANY • DEPT. SAJ, 200 EAST STREET, NEW HAVEN 5, CONN.

How the image you see gets PARAGON®



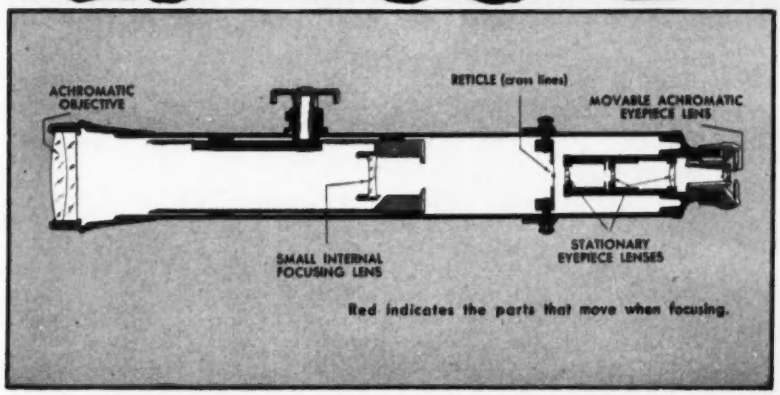
Even an ordinary reading glass can produce an image of sorts. That happens when the sun's rays are focused on a piece of paper as shown. All the rays passing through the lens concentrate at approximately one point where they form a small inverted picture or image of the sun.

By means of a lens, rays from any object at a distance can be made to concentrate inside a telescope in the same way. They form a tiny inverted picture of the object. If a screen like the ground glass of a camera were placed there and viewed through a magnifying glass, the actual picture of the distant object could be seen clearly. The lens that brings the tiny picture into a telescope is called the objective, and the small but powerful microscope that brings it out of the telescope into the eye is called the eyepiece.



into and out of a Telescope

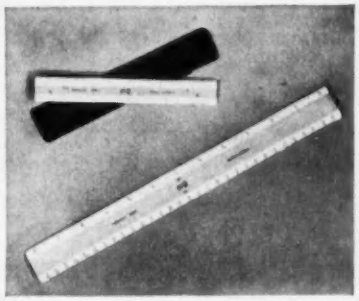
The Right Angle


ACHROMATIC OBJECTIVE
RETICLE (cross lines)
MOVABLE ACHROMATIC EYEPIECE LENS
SMALL INTERNAL FOCUSING LENS
STATIONARY EYEPIECE LENSES
Red indicates the parts that move when focusing.

Cross lines so fine as to be almost invisible can be placed inside the instrument at exactly the place where the miniature picture is formed. Then the eyepiece will greatly magnify not only the picture but the cross lines as well so that both are seen together. Basically, that is the principle of the telescopes used in K&E PARAGON surveying instruments and K&E optical tooling equipment. These contain additional refinements, such as a movable internal lens for focusing and extra lenses in the eyepiece that invert the picture a second time, so that the eye sees it right side up.

Naturally, the above description is extremely elementary. In fine telescopes, such as those made by K&E, every optical part must be made with surpassing accuracy so that the rays of light are not scattered. It is for this reason that K&E designs, grinds and polishes its lenses with an accuracy measured in millionths of an inch. The result is superior definition with unusual contrast and brightness. Minute detail can be clearly distinguished, and cross lines appear jet black.

These are the exacting standards to which K&E builds instruments for engineers, surveyors and builders, as well as optical tooling equipment. The latter makes possible the application of surveying methods to manufacturing and construction problems involving high-precision positioning and alignment. Already these techniques have revolutionized tooling in the aircraft industry and are being adopted in other fields. Ask your K&E Distributor or Branch for details on what these superlative instruments can do for you.



Measuring scales are in constant use on every drawing board. For high quality and accuracy, use K&E PARAGON engine divided scales. They are made of the highest grade boxwood with scale faces of white plastic, permanently cemented. The graduations are filled with dense black pigment for high visibility against the white background.

There is a K&E graph sheet for almost every purpose. In a selection of 300 forms you can find graph sheets for plotting scientific data, forms for sketching and drawing, both mechanical and architectural, or for surveying and mapping. Also, business and financial forms of all types. All are on high quality drawing paper and on the finest tracing paper.

K+E

PARTNERS IN CREATING

KEUFFEL & ESSER CO.

EST. 1867

Drafting, Reproduction, Surveying Equipment and Materials, Slide Rules, Measuring Tapes

NEW YORK • HOBOKEN, N. J.
CHICAGO • ST. LOUIS • DETROIT
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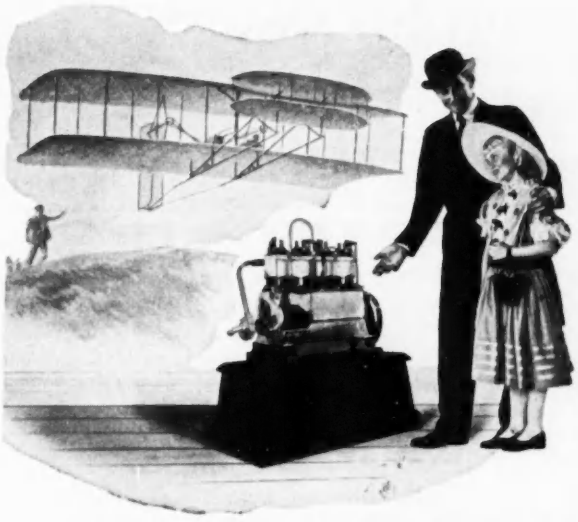
jet power packages by

ROHR

WORLD'S LARGEST PRODUCER OF READY-TO-INSTALL POWER PACKAGES FOR AIRPLANES

ROHR
AIRCRAFT CORPORATION CHULA VISTA AND RIVERSIDE CALIFORNIA



THE BOX KITE PLANES of fifty years ago had engines so small a man could lift one single handed. Modern flying box cars carry freight-car loads across the continent in a few hours. Bigger engines with minimum weight per horse-power are required. The performance of every part must be taken for granted—therefore must be flawless and precision made. The Special Products Division at Thompson Products specializes in making such parts.

Valve seat inserts, pistons and piston pins made by Thompson to the most exacting specifications—with the closest tolerances known to the industry—

Engine Performance you can take for granted!

are supplied to leading aircraft manufacturers for the modern airplane engines of today.

The skills and manufacturing facilities required in the production of these parts are used in making other engine parts. The same "jeweler's precision" used in making the parts for a mighty aircraft engine goes into Thompson's valve seat inserts for Walker Bulldog tanks as well as the insert that is used in many of the mass-produced automobiles that are so essential to our way of living.

If you are having trouble with engine parts—if you need a better, more dependable supplier, just write or call Special Products Division, Thompson Products, Inc., 2196 Clarkwood Rd., Cleveland 3, Ohio.

Valve Seat Insert for aircraft engine

You can count on

Thompson Products

SPECIAL PRODUCTS DIVISION

AMERICAN CHEMICAL PAINT COMPANY

AMBLER CHEMICALS ACP PROCESSES PENNA.

Technical Service Data Sheet
Subject: Protecting Aluminum with "*ALODINE*"®

INTRODUCTION

Aluminum not only corrodes when exposed unpainted to the atmosphere (particularly in moist, salt-laden air or industrial fumes) but also sheds paint unless the surface is actually changed prior to finishing. Simple treatments involving cleaning, or etching, or both, which heretofore have been used extensively, do not change the chemical composition of the surface and are inadequate. Far from retarding the corrosion of unpainted aluminum, such processes may in fact stimulate it.

In general, coatings integral with the aluminum itself have proved to be far more effective than cleaning and etching treatments for bonding paint and protecting the metal. "Alodine", which forms a stable, durable, non-metallic surface on aluminum, anchors the paint finish, prolongs paint life, and protects aluminum exposed unpainted in moist and salt-laden atmospheres.

CHARACTERISTICS OF THE "ALODINE" COATING	
TYPE	Non-metallic surface, integral with aluminum it protects.
COLOR	Depending on alloy treated, color range is from an iridescent blue-green to a dark slate grey.
THICKNESS	From 0.01 to 0.08 mil. No appreciable dimensional changes occur when aluminum is Alodized.
WEIGHT	50 to 300 mgs. per square foot. Optimum: 100 to 200 mgs. per square foot.
SOLUBILITY	Insoluble in water, alcohol, solvents, etc. Insoluble in most dilute acids and alkalis. However, strong acids and alkalis which attack aluminum may penetrate the "Alodine" film and react with the underlying metal. Slightly soluble in concentrated nitric acid. Soluble in molten sodium nitrate, etc.
ELECTRICAL RESISTANCE	High diaelectrical resistance.
HEAT STABILITY	Unimpaired at temperatures that melt aluminum.
FLEXIBILITY	Integral with and as flexible as the aluminum itself. Can withstand moderate draws.
ABRASION RESISTANCE	Approximately 90% of that provided by chromic acid anodized aluminum.
SALT SPRAY	Painted—superior to chromic acid anodizing. Unpainted—comparable with chromic acid anodizing.
PAINT-BONDING	Excellent. Equal to or superior to anodizing.
TOXICITY	Non-toxic.
BIMETALLIC CORROSION RESISTANCE	Shows good resistance against bimetallic or galvanic corrosion.

ALODIZING IS EASY AND EFFECTIVE

The Alodizing process is a chemical one and does not require electrolytic techniques or equipment. Alodizing is simple, foolproof, low in cost, and requires a minimum of equipment. Essentially, the process consists of the following easily controlled operations or steps:

1. Cleaning the work.
2. Rinsing the cleaned aluminum surfaces.
3. Coating with "Alodine."
4. Rinsing with clean water.
5. Rinsing with warm "Deoxylyte" (acidulated rinse).
6. Drying.

After treatments. Alodized aluminum provides an ideal bonding surface for paint, wax, adhesive, or other organic finishes. These should be applied in accordance with the manufacturer's directions. Unpainted or exposed areas will be protected by the tough, durable "Alodine" surface.

"ALODINE" MEETS SERVICE SPECIFICATIONS

"Alodine" applied by immersion or spray complies with the rigid performance requirements of both industrial and Government specifications. The following is a list of Service Specifications which "Alodine" meets at the present time.

MIL-C-5541	U. S. Navord O.S. 675
MIL-S-5002	16E4 (SHIPS)
AN-F-20	AN-C-170 (See MIL-C-5541)

U.S.A. 72-53 (See AN-F-20)

BRUSH "ALODINE" PROTECTS ALUMINUM IN THE FIELD, SHOP, OR HANGAR

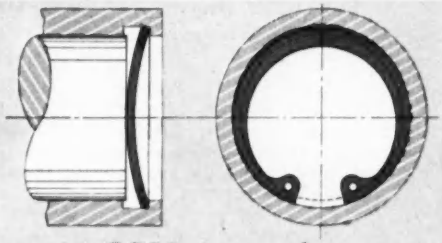
Brush "Alodine" is easily applied in a simple brush-on or flow coat process to large assemblies and surfaces—airplanes, trucks, trailers, boats, housing, building siding, railway cars, bridges, etc.—that are too bulky or too remote to be conveniently treated in tanks or a multi-stage power spray washer. The cleaning and coating chemicals for Brush Alodizing are shipped in bulk or in the convenient Brush "Alodine" Chemical Kit No. 1. This Kit contains enough chemicals to treat about 1,000 square feet of surface and is an ideal package for use at airfields of commercial airlines or of the Armed Services anywhere.

CHEMICALS ACP PROCESSES

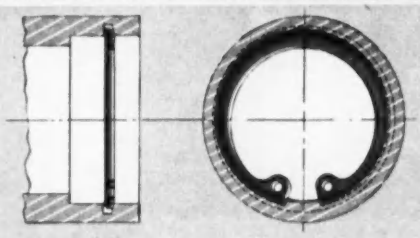
WRITE FOR FURTHER INFORMATION ON "ALODINE" AND ON YOUR OWN ALUMINUM PROTECTION PROBLEMS.

CHEMICALS ACP PROCESSES

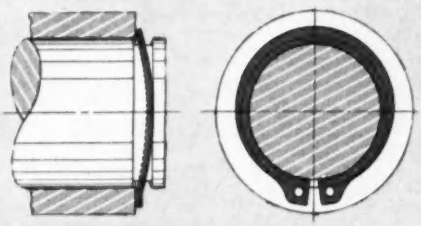
if end-play take-up is a problem
one of these special Waldes Truarc rings can solve it



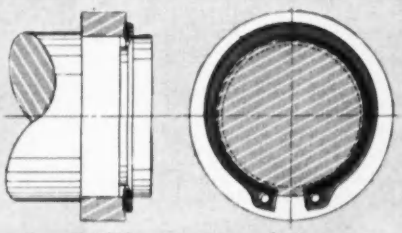
series 5001 · internal type
for bore diameters from: .250 – 1.456 in.



series 5002 · internal type
for bore diameters from: 1 – 10 in.



series 5101 · external type
for shaft diameters from: .188 – 1.438 in.



series 5102 · external type
for shaft diameters from: 1 – 10 in.

bowed WALDES TRUARC RETAINING RINGS

Take up end-play resiliently, damp vibrations and oscillations. Bent like a bow out of plane at horizontal center line. The bowed Truarc ring acts in axial direction like a floating spring without losing its tight grip against the bottom of the groove.

Maximum resilient end-play take-up: .015" to .020" depending on size of ring.

beveled WALDES TRUARC RETAINING RINGS

Take up end-play rigidly. When the ring is contracted (or expanded), the tapered edge acts like a wedge moving deeper into the groove and shifting in an axial direction until the ring abuts the machine part.

Maximum end-play take-up, depending on ring size: internal types, .005" to .043"; external types, .005" to .040".

WALDES TRUARC is much more than a better way to hold parts together

Thousands of manufacturers have already found that Truarc Retaining Rings cut production costs and speed assembly by simplifying product design. But that's not all.

Waldes Truarc engineers have extended the use of retaining rings by developing rings that perform *additional functions* while acting as retaining shoulders. Those shown here take up end-play, compensate for wear and varying manufacturing tolerances.

No matter what your problem, there's a Waldes Truarc Ring designed specifically to solve it. Send us your drawings, your questions—Waldes Truarc engineers will work with you, at no obligation.

SEND FOR NEW CATALOG

WALDES
TRUARC
REG. U. S. PAT. OFF.
RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS: 2,383,947; 2,398,948; 2,410,931; 2,420,921; 2,428,341; 2,439,785; 2,441,849; 2,455,165; 2,483,390; 2,483,393; 2,487,692; 2,487,903; 2,491,306; 2,509,091 AND OTHER PATENTS PENDING.

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.

Please send me the new Waldes Truarc Retaining Ring catalog.

(Please print) SA 025

Name .....

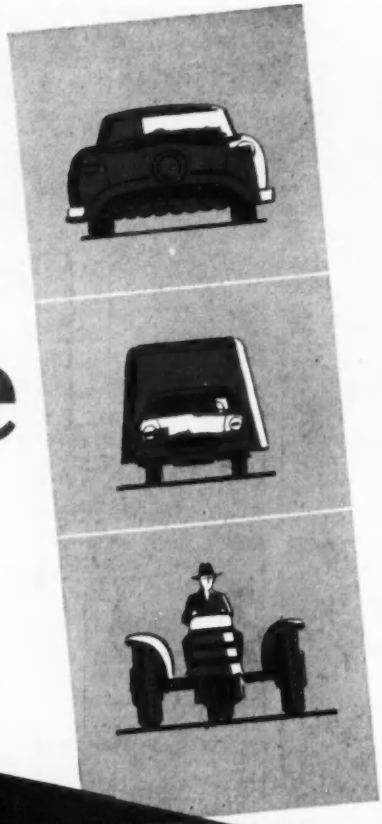
Title .....

Company .....

Business Address .....

City ..... Zone ..... State .....

first choice



for modern cars, trucks and tractors

"No Kick-Out" feature combines new starting efficiency with proven economy

• Higher compression ratios, lighter flywheels and other advancements in modern engines have long pointed up the need of a starter drive that would follow through the weak explosions until the engine actually runs on its own power.

That's why vehicle manufacturers are turning in ever increasing numbers to the Bendix* Folo-Thru Drive as the solution to quicker and more dependable starting even under most adverse conditions.

This preference for the Bendix Folo-Thru Drive on modern vehicles is a most logical one, for Bendix Drives have always been the industry's choice as the most economical and efficient starting equipment.

*REG. U. S. PAT. OFF.

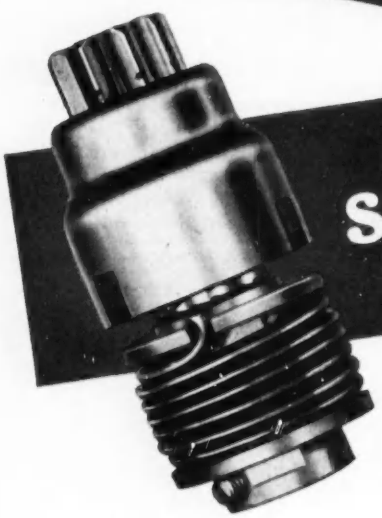
ECLIPSE MACHINE DIVISION of

Bendix AVIATION CORPORATION

ELMIRA, NEW YORK

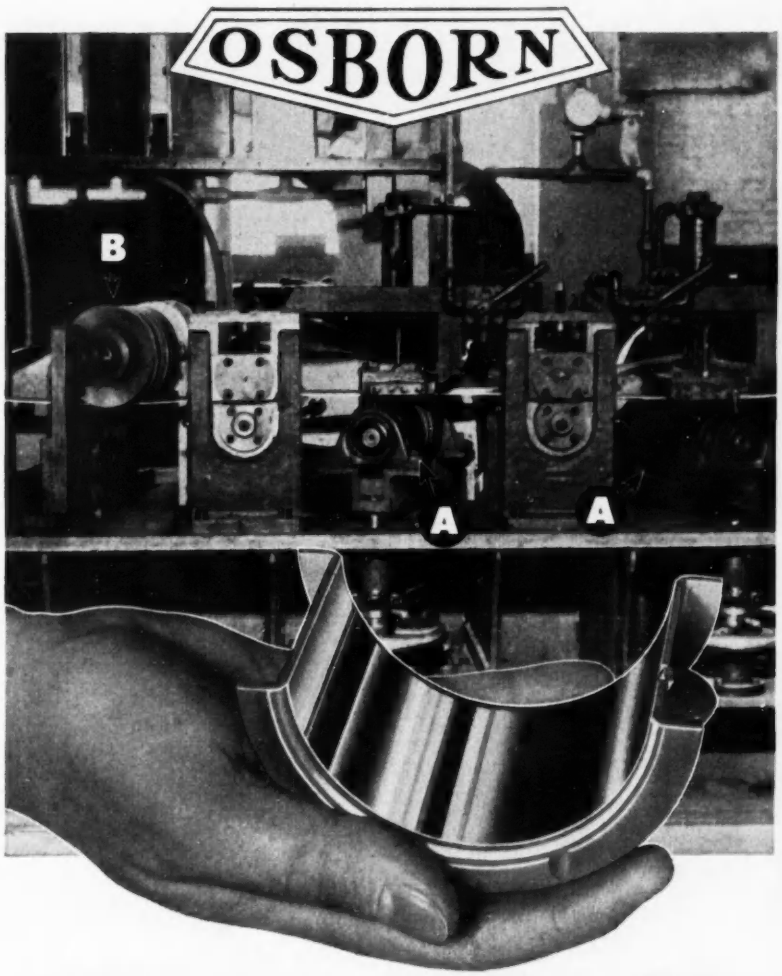
Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, N. Y.

Bendix folo-thru starter drive



costs less. *Like the more than 95,000,000 Bendix* Starter Drives manufactured for the industry, the new Folo-Thru Drive requires no actuating linkage and the solenoid may be placed in any convenient position. Result is lower installation costs and no adjustments. Complete detailed information is available on request.*

Bendix* Folo-Thru Starter Drive Bendix* Automotive Electric Fuel Pump Stromberg* Aeroquad Carburetor



Will "automatic" ideas like these cut your costs?

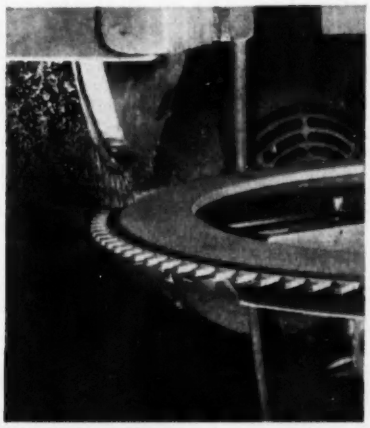
THIS machine does two jobs at one time . . . does them thoroughly by power brushing . . . at the push of a button.

Perhaps a similar brushing method can help cut *your* costs, boost *your* production and improve the quality of *your* products.

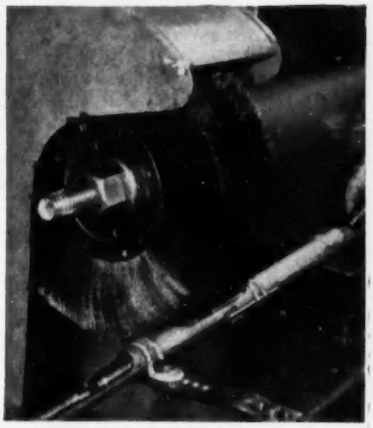
The machine developed with the help of the **O**sborn **B**rushing **A**nalyst cleans steel-backed, babbitt-lined strip for production of automotive sleeve bearings. With the strip traveling continuously, Osborn Master® Wheel Brushes (A) remove all dirt, rust and metal particles from the steel surface. Osborn Monarch® Sections (B) then thoroughly clean the babbitt side.

This is typical of the cooperation which your **O**sborn **B**rushing **A**nalyst can give *you* to solve problems of product cleaning, burr removal, roughing, polishing and finishing. For help, call or write *The Osborn Manufacturing Company, Dept. S-1, 5401 Hamilton Avenue, Cleveland 14, Ohio.*

Osborn Brushes



SAVES 12 MEN. This is one station of a five-station rotary automatic machine equipped with Osborn power brushes that removes burrs and sharp corners of clutch disc teeth. Formerly done by hand. Saves 12 skilled men.

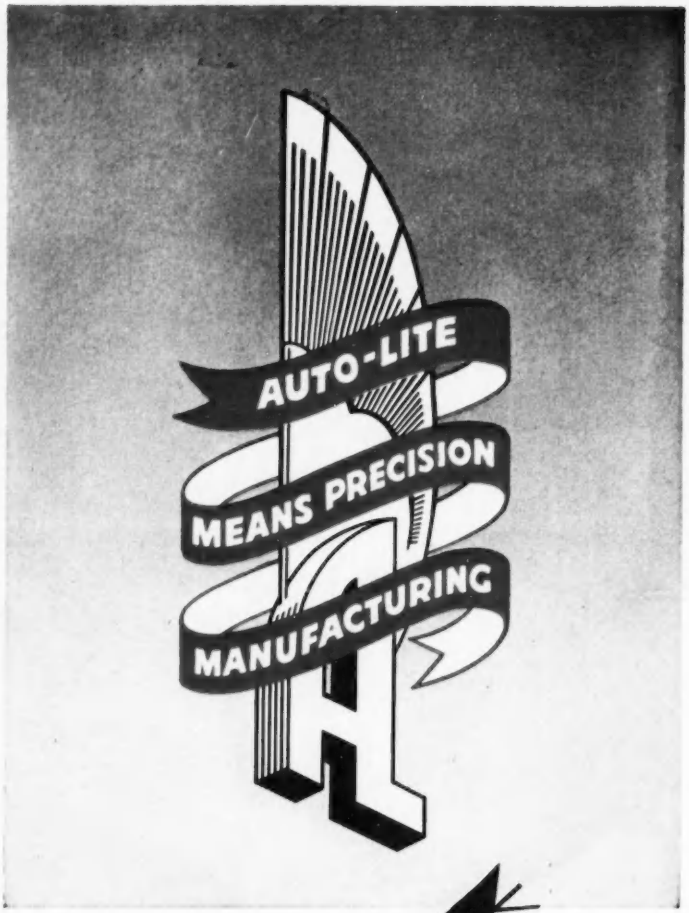


9 TIMES AS FAST. This simple pipe fixture provides the means of cleaning threads of set screws. Can be applied to many cylindrical parts. Time was cut from 18 seconds to 2 seconds with this Osborn brushing idea.

10 TIMES AS FAST. This shows two gears before and after deburring by a new Osborn power brushing method. Note smooth uniform results. Time was cut from 3 minutes to 18 seconds.

OSBORN POWER, MAINTENANCE AND PAINT BRUSHES AND FOUNDRY MOLDING MACHINES

You're always right with

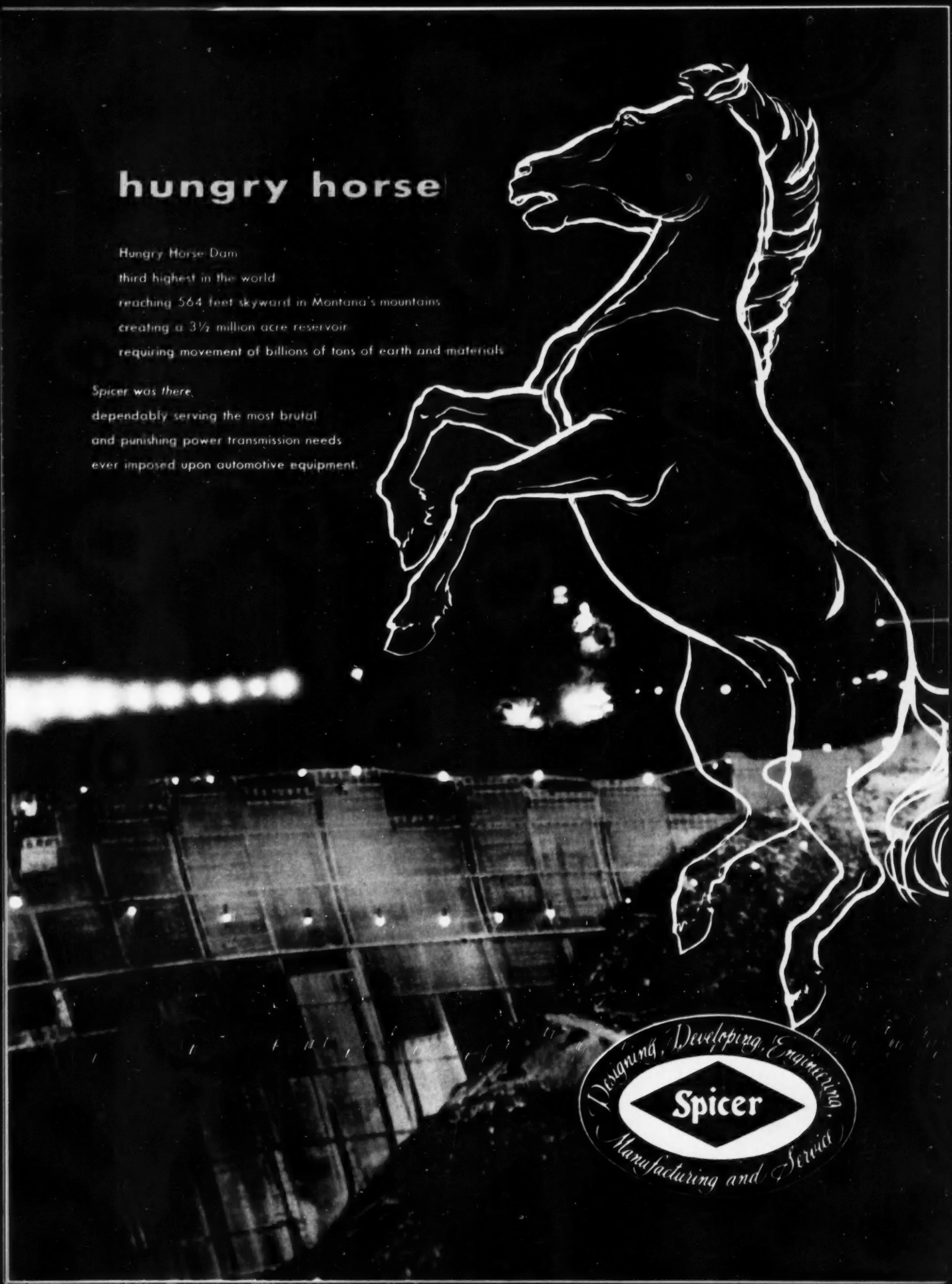


AUTO-LITE

AUTO-LITE works to serve the nation's needs in peace and in defense. In 28 great Auto-Lite plants from coast to coast, Auto-Lite produces more than 400 products which are original equipment on many makes of America's finest cars, trucks, tractors, airplanes and boats. Their 40-year record of dependable performance is summed up in the phrase, "You're Always Right With Auto-Lite."

THE ELECTRIC AUTO-LITE COMPANY
Toledo 1, Ohio — Toronto, Ontario

Spark Plugs · Fuel Pumps · Batteries · Bumpers · Generators · Speedometers
Horns · Switches · Moulded Plastics · Speedometer Cable
Starting Motors · Ignition Units · Instruments & Gauges · Windshield Wipers
Lighting Units · Wire & Cable · Gray Iron Castings
Window Lifts · Metal Fabricated Assemblies · Zinc & Aluminum Base Die Castings


hungry horse
Hungry Horse Dam
third highest in the world
reaching 564 feet skyward in Montana's mountains
creating a 3½ million acre reservoir
requiring movement of billions of tons of earth and materials
Spicer was there,
dependably serving the most brutal
and punishing power transmission needs
ever imposed upon automotive equipment.
Designing, Developing, Engineering,
Spicer
Manufacturing and Service

hungry for horsepower

Biggest in the world are Boulder . . . Shasta . . . Hungry Horse . . . Grand Coulee . . . Ross . . . and other great American water-impounding structures.

Their demands for construction horsepower were stupendous. And adequately met by the automotive industry's designing and manufacturing genius. In all kinds of motive power units used for these immense dam-building jobs, Spicer Universal Joints, Clutches and Transmissions helped to complete time schedules that were *hungry for horsepower.*

Spicer—Standard of the Industry

SPICER MANUFACTURING DIVISION *of Dana Corporation*
TOLEDO 1, OHIO

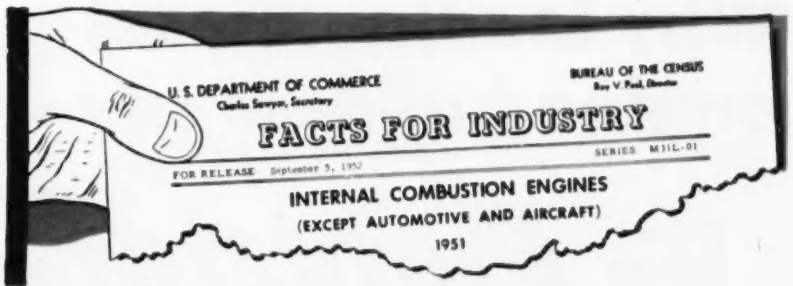
49 YEARS OF Spicer SERVICE

ENGINEERING DANA MANUFACTURING

We Endorse the Junior Achievement Program

TRANSMISSIONS • UNIVERSAL JOINTS • BROWN-LIPE AND AUBURN CLUTCHES • FORGINGS • PASSENGER CAR AXLES • STAMPINGS • SPICER "BROWN-LIPE" GEAR BOXES • PARISH FRAMES • TORQUE CONVERTERS • POWER TAKE-OFFS • POWER TAKE-OFF JOINTS • RAIL CAR DRIVES • RAILWAY GENERATOR DRIVES

Latest Census Report Provides Proof


U. S. DEPARTMENT OF COMMERCE
Charles Sawyer, Secretary

BUREAU OF THE CENSUS
Roy V. Peel, Director

FACTS FOR INDUSTRY

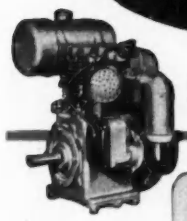
FOR RELEASE September 5, 1952

SERIES M31L-01

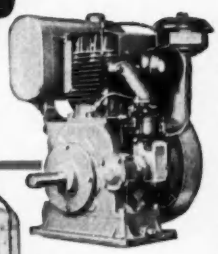
INTERNAL COMBUSTION ENGINES
(EXCEPT AUTOMOTIVE AND AIRCRAFT)
1951

# of Overwhelming Preference for WISCONSIN HEAVY-DUTY *Air-Cooled* ENGINES

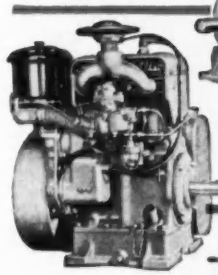
50.61% of Aggregate Total, 3 to 40 H. P. Engines made in 1950-'51 were WISCONSINS



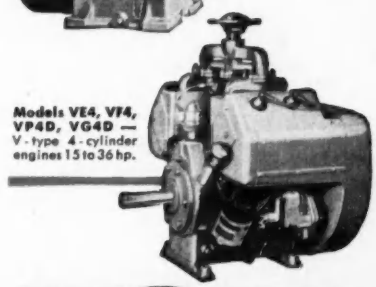
Models ABN, AKN, AEN Single cylinder engines 3 to 8½ hp.



Models AFH, AGH, AHH — single cylinder engines 6 to 9 hp.



Models TE and TF 2-cylinder engines 7 to 14½ hp.



Models VE4, VF4, VP4D, VG4D — V-type 4-cylinder engines 15 to 36 hp.

It is no idle boast when Wisconsin Motor Corporation is referred to as "No. 1 Source" for Heavy-Duty Air-Cooled Engines. Overwhelming verification of this statement is established through statistics presented in a Bureau of the Census report, released on Sept. 5, 1952, covering the production of all types of internal combustion engines (except aircraft and automotive).

Based on figures contained in this report, 50.61% (1950-'51 average) of all engines produced within an 11 to 175 cu. in. displ. range (approx. 3 to 40 hp.) were Wisconsin Air-Cooled Engines, exclusive of outboard marine and so-called "captive" engines built by various manufacturers for use on their own original equipment.

Here is positive *proof of preference* for Wisconsin Air-Cooled Engines by builders and users of power-operated equipment in all fields where dependable, heavy-duty engine service is required. These engines have been *pre-judged* and *pre-selected* by more power-wise purchasers than all other makes of engines combined, within their power range!

This universal preference is based on such factors as ideal adaptability of Wisconsin Engines to fit both the machine and the job; easy starting and trouble-free air-cooling under all weather and climatic conditions; low-cost maintenance; ready availability of factory-trained servicing and original replacement parts . . . plus *outstanding performance.*

It will pay you to specify "Wisconsin Power" for your equipment. Complete descriptive and engineering data on request.

WISCONSIN MOTOR CORPORATION

World's Largest Builders of Heavy-Duty Air-Cooled Engines

MILWAUKEE 46, WISCONSIN

Why leading diesel engine builders say—

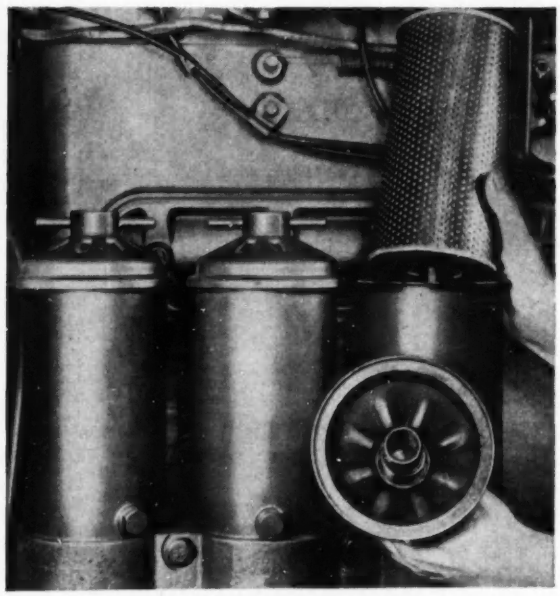
It's *Purolator** for Full-Flow!

- **Full-flow rates within practical filter dimensions:** Purolator's famous "accordion-pleated" Micronic* filter element has up to ten times more filtering area than old-style filters—gives high flow rates in a minimum of space.
- **Ultra-micronic filtration:** High flow rates are, of course, meaningless unless effective filtration is maintained, too. Electron micrographs prove that the Purolator Micronic filter stops particles down to *submicrons*—.0000039 in.!
- **Maximum dirt storage capacity:** The pleated design of the Micronic filter element provides many times more dirt storage space than old-style filters. This important advantage means uniform, efficient performance and a lengthy service life.
- **Minimum pressure drop:** The Purolator Micronic filter element introduces a remarkably small pressure drop in the lubricating system . . . permitting pumps of practical size and simple type.
- **Will not remove or absorb additives:** With Purolator Micronic filtration, you keep *all* the oil quality you pay for. The Micronic filter element will not strip additives . . . an important advantage with HD and heat-resistant oils

Modern engines with full-flow lube systems . . . which filter *all* the oil at each pass through the engine . . . demand the best in filters. And most leading makers of diesel engines and vehicles agree that the best is *Purolator** . . . a fact proved over and over by their own impartial tests.

The story's the same with gasoline engines, too! The world's best known producers of passenger cars, trucks, tractors, earth-moving equipment, and stationary engines have found Purolators best . . . and install them as standard factory equipment.

If you are contemplating new designs or modifications of existing ones, remember . . . there's a well-engineered and use-tested Purolator for *any* filter application, including fuel oil, gasoline, hydraulic fluid, and water. Write for the Purolator catalog issued for your special field.



Purolator Micronic Filters in a typical Diesel full-flow installation. Although the Purolator Micronic filter elements measure only 4½ in. by 9 in., *each one filters 9 gallons of oil per minute*, giving a total of 27 g.p.m. for the complete filter unit.

PUROLATOR PRODUCTS, INC.
Rahway, New Jersey, and Toronto, Ontario, Canada
Factory Branch Offices: Chicago, Detroit, Los Angeles

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PUROLATOR
MICRONIC OIL FILTER
"FIRST IN THE FIELD OF FILTERING"

Autocar

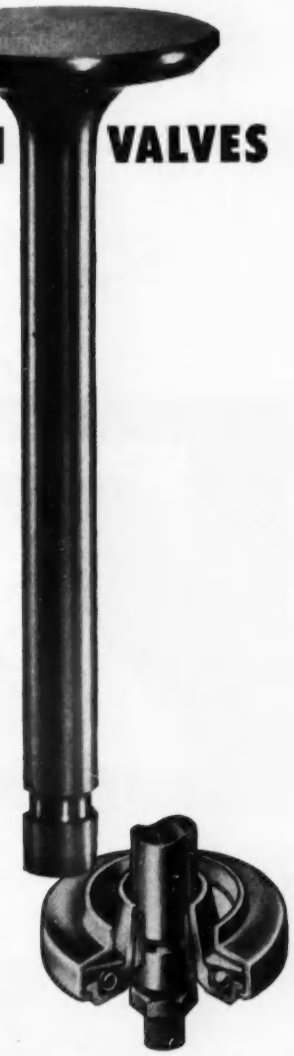
another famous name that depends on

THOMPSON VALVES

Big trucks or middle-size, over-the-road or off-the-highway . . . if they are powered by Autocar engines, they use Thompson valves.

Autocar engineers give Thompson engineers the engine service requirements, rely on Thompson for design, engineering, and production of valves that will help maintain the Autocar reputation for economy and long life.

Take a tip from Autocar and other leading engine builders . . . count on Thompson for engineering leadership.

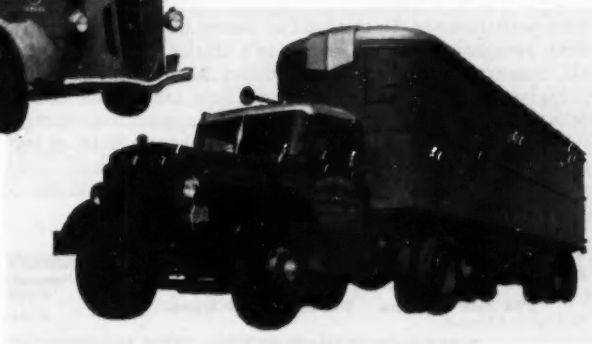


Thompson-developed "Rotocaps" help add thousands of miles to valve life.

VALVE DIVISION

Thompson Products, Inc.

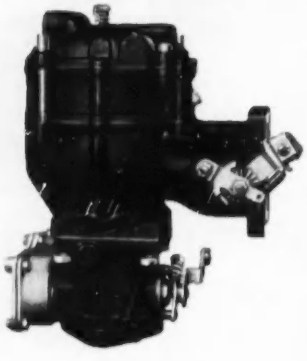
CLEVELAND 17, OHIO



Does He Knock or Boost Your Truck?

IT ALL DEPENDS ON PERFORMANCE and PERFORMANCE DEPENDS ON

Zenith CARBURETORS



What drivers and operators say about your vehicles has a mighty important bearing on the future of your business. So it is imperative that every component be selected on the basis of its contribution to lasting, satisfactory performance. In the field of heavy duty carburetion Zenith* has long been recognized as the engineer's choice for quality performance under all operating conditions. You can be sure that manufacturers whose vehicles are Zenith equipped measure carburetor costs in lasting terms rather than initial expense. Zenith's rugged construction, strong idling, freedom from stalling and obedient response to every power demand goes a long way toward building owner good will. That's why cost conscious operators and experienced drivers prefer Zenith equipped vehicles.

*REG. U.S. PAT. OFF.

ZENITH CARBURETOR DIVISION OF
696 Hart Avenue · Detroit 14, Michigan

Bendix
AVIATION CORPORATION

Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, N. Y.

NEED BEARINGS OR PARTS
that meet these powder metallurgy specs?

"COMPO"® and "POWDIRON"®
conform to all these . . . and many others!

SPECIFICATION	WHAT IT COVERS
ASTM B202-45T Type 1 Class A	Bearings purchased by industry.
MIL-B-5687 A Type 1 Composition A	Approved by Departments of Army, Navy and Air Force for procurement of bearings.
U. S. Army 57-230-2 Type 1 Composition A	Bearings used by all agencies of U. S. Army including Ordnance and Signal Corps.
SAE Gen. Instr. P221-1951 Handbook Type 1 Class A	Bearings used by automotive and related industries.
AMS-4805	Bearings used by aircraft manufacturers and sub-contractors.
ASTM B202-45T Type 2 Class B	Bearings purchased by industry.
ASTM B222-47T	Structural parts used by industry.
MIL-B-5687A Type 2 Composition B	Approved by Departments of Army, Navy and Air Force for procurement of bearings and parts.
U. S. Army 57-230-2 Type 2 Composition B	Bearings used by all agencies of U. S. Army including Ordnance and Signal Corps.
SAE Gen. Instr. P2221 1951 Handbook Type 2 Class B	Bearings used by automotive and related industries.

Use "Compo" H

Use "Powdiron" 61-P

Just about *every* major powder metallurgy specification—whether it's issued by government agencies or by official societies—is met either by "COMPO" H (oil-retaining porous bronze) or "POWDIRON" 61-P (sintered iron). Special alloys in "COMPO" and "POWDIRON" are also available to meet specific or unusual requirements.

Write Dept. B-2, Bound Brook Oil-Less Bearing Company, Bound Brook, N. J., for details.

Better Buy Bound Brook

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BOUND BROOK, N. J. • BOUND BROOK 9-0441
Manufacturers of bearings and parts — Established 1883

How a jet engine runs on its "nerves"

Auxiliary "nerve center" of a jet's engine, this complex gearbox transmits the power that runs oil and fuel pumps, generators, and other vital accessories. To produce this intricate unit for J-40 engines, Westinghouse looks to Lycoming for precision production.

From a jet's mighty engine, these precision gears "take off" power and pass it along to vital accessory equipment *at the specific rate required by each different* unit. As many as 30 separate gears . . . as many as 2500 separate machining and assembly operations . . . go into this gearbox so essential to safe, efficient operation of a jet. And for this tremendously complex production, Westinghouse depends on Lycoming.

Lycoming stands ready to assist *you*, too. Whether you have "just an idea" that needs development, a problem in the blueprint stage, or a finished metal product that needs precise, speedy fabrication . . . you can depend on Lycoming's long-tested ability to meet the most exacting and diverse industrial or military requirements. *Whatever* your problem—look to Lycoming!

Lycoming's 2½ million feet of floor space, its more than 6,000 machine tools, and its wealth of creative engineering ability stand ready to serve your needs.

AIR-COOLED ENGINES FOR AIRCRAFT AND INDUSTRIAL USES • PRECISION-AND-VOLUME MACHINE PARTS • GRAY-IRON CASTINGS • STEEL-PLATE FABRICATION

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Please send me further information on Lycoming's varied abilities and facilities.

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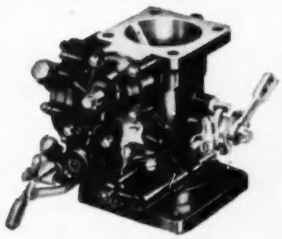
STROMBERG

SELECTED FOR Le Sabre



Stromberg Carburetor
PS-5C used on Le Sabre

An experiment in the automotive future—a low sleek sports car with dramatic, sweeping lines of a jet aircraft is how General Motors describes its new car, the Le Sabre.

Every advanced engineering and styling feature was planned with the thought of finding out if the futuristic ideas of today might prove to be the accepted standard of tomorrow's conventional motor car.

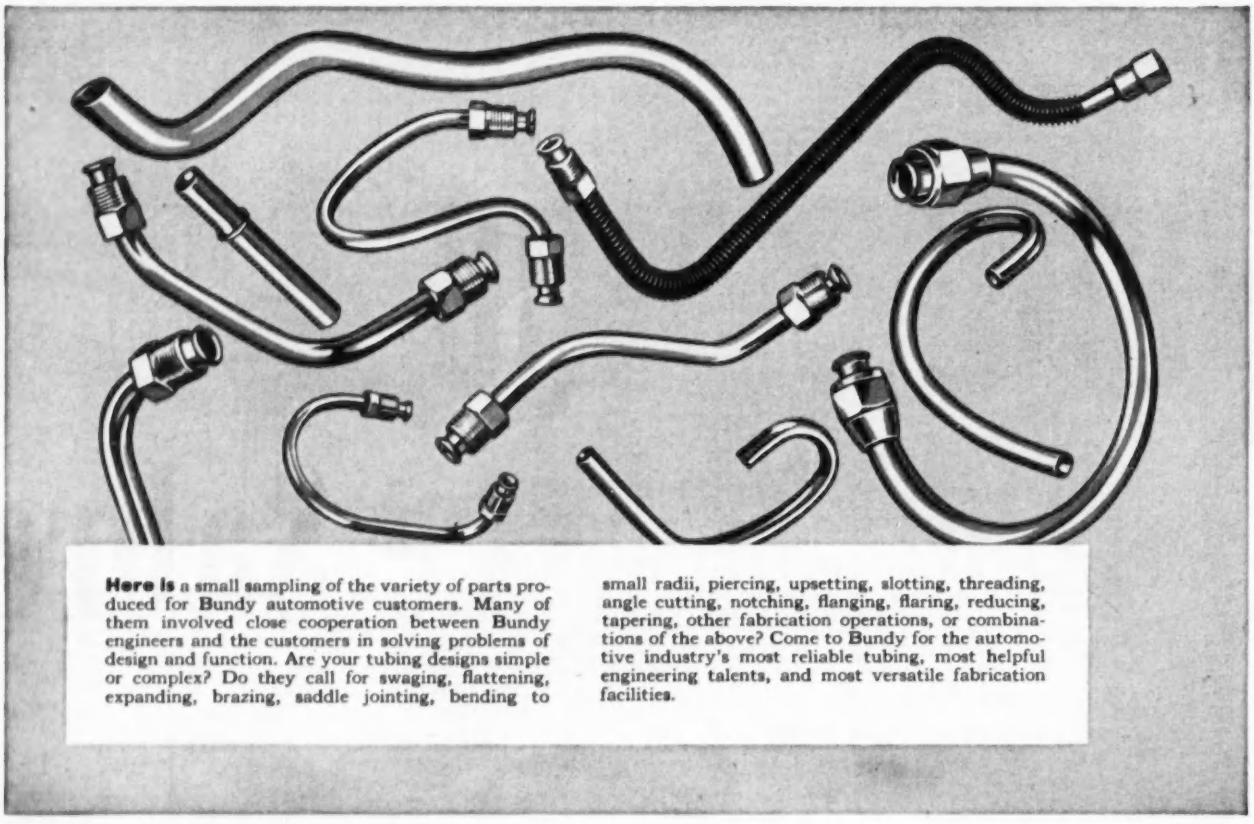
For example, although Le Sabre carburetion presents an entirely new problem due to the use of methyl alcohol, together with current premium fuel, the carburetor itself is a specially designed Stromberg—the quality carburetor on today's conventional motor car.*

For any car manufacturer planning for future requirements or meeting today's need for finer, more dependable carburetion—Stromberg is the answer.

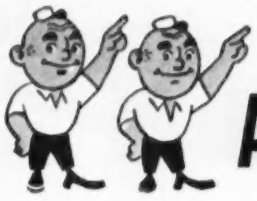
*REG. U.S. PAT. OFF.

ECLIPSE MACHINE DIVISION OF
ELMIRA, NEW YORK

Bendix
AVIATION CORPORATION



Here is a small sampling of the variety of parts produced for Bundy automotive customers. Many of them involved close cooperation between Bundy engineers and the customers in solving problems of design and function. Are your tubing designs simple or complex? Do they call for swaging, flattening, expanding, brazing, saddle jointing, bending to small radii, piercing, upsetting, slotting, threading, angle cutting, notching, flanging, flaring, reducing, tapering, other fabrication operations, or combinations of the above? Come to Bundy for the automotive industry's most reliable tubing, most helpful engineering talents, and most versatile fabrication facilities.



Almost no limit to what we can do for you with Bundyweld Tubing

WHY BUNDYWELD IS BETTER TUBING

Bundyweld starts as a single strip of copper-coated steel. Then it's . . .

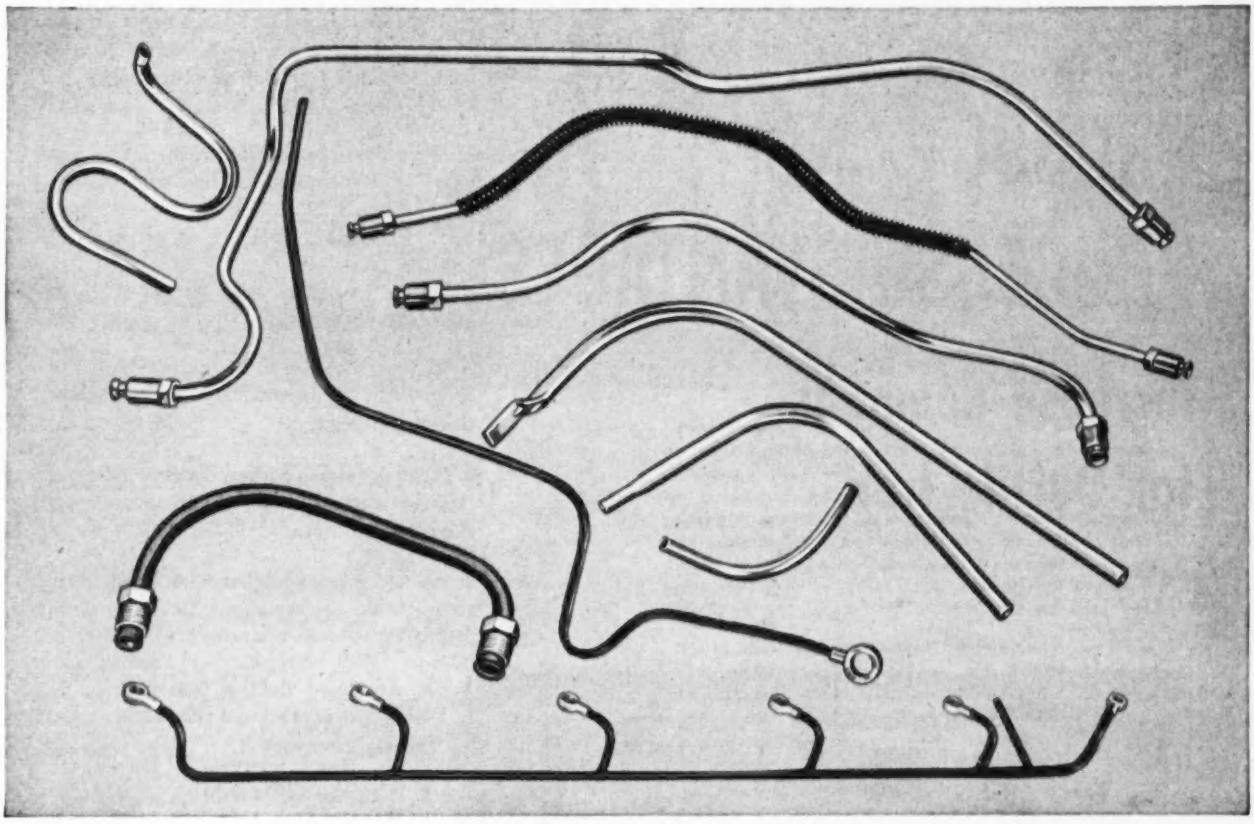
continuously rolled twice around laterally into a tube of uniform thickness, and

passed through a furnace. Copper coating fuses with steel. Result . . .

Bundyweld, double-walled and brazed through 360° of wall contact.

← **NOTE** the exclusive patented Bundyweld beveled edges, which afford a smoother joint, absence of bead and less chance for any leakage.

Bundy Tubing Distributors and Representatives: *Cambridge 42, Mass.:* Austin-Hastings Co., Inc., 226 Binney St. • *Chattanooga 2, Tenn.:* Poirson-Deakins Co., 823-824 Chattanooga Bank Bldg. • *Chicago 32, Ill.:* Lapham-Hickey Co., 3333 W. 47th Place • *Elizabeth, New Jersey:* A. B. Murray Co., Inc., Post Office Box 476 • *Philadelphia 3, Penn.:* Rutan & Co., 1717 Sansom St. • *San Francisco 10, Calif.:* Pacific Metals Co., Ltd., 3100 19th St. • *Seattle 4, Wash.:* Eagle Metals Co., 4755 First Ave. South *Toronto 5, Ontario, Canada:* Alloy Metal Sales, Ltd., 181 Fleet St., East • **Bundyweld nickel and Monel tubing is sold by distributors of nickel and nickel alloys in principal cities.**



It almost goes without saying that you can't beat Bundyweld for leak-proof, dependable performance in your brake, oil, and gasoline lines and in other tubing lines throughout your cars, trucks, or tractors.

But you get more than peace of mind with Bundyweld. For instance, you tap a wealth of fabrication facilities and engineering skills.

Do your tubing part designs call for difficult fabrication operations or easy ones? Do the designs call for unusual combinations of operations? Do they create problems that may seem unsolvable?

If your needs call for a tubing part that is at all produceable, you can count on us to do the job—exactly to specifications at lowest possible cost to your company. But say it isn't produceable. What then?

Just this. Bundy engineers who know their Bundyweld and automotive tubing problems inside and out will work with you personally until problems turn into solutions. This help and teamwork pay off in time and trouble saved. And such a pooling of specialized skills—yours and the Bundy man's—frequently pays off in lowered material costs and lowered production costs, too.

What if *your* company is geared for low-cost fabrication? Wonderful. You can count on us to ship clean, carefully inspected Bundyweld on time and in specified straight lengths. Of course, you can still summon all the engineering help you can use.

For tubing that's the standard of dependability, for fabrication facilities and engineering talents devoted to producing better parts at lowest possible cost, come to headquarters for small diameter tubing.

BUNDY TUBING COMPANY

DETROIT 14, MICHIGAN

Bundyweld® Tubing

DOUBLE-WALLED FROM A SINGLE STRIP

PRODUCT AND PROCESS ADVANTAGES

increase demands for Ductile Iron

DUCTILE IRON PROVIDES mechanical properties which approach those of cast steel. In addition, it combines the *machinability and wear-resistance* as well as the *fluidity and castability* of cast iron.

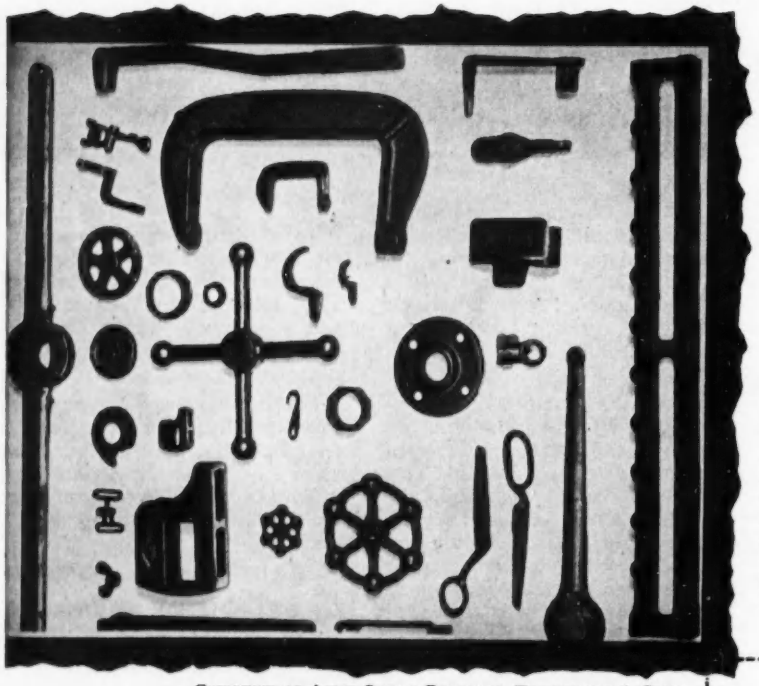
Presence of spheroidal rather than flake graphite not only gives this new material ductility that is unique among cast irons, but contributes much to its other exceptional properties.

REMARKABLE CHARACTERISTICS OF DUCTILE IRON

1. Its elastic modulus, about 25,000,000 psi, is virtually unaffected by composition or thickness...

2. It can provide a chilled, carbidic, abrasion-resistant surface supported by a tough ductile core.

3. As-cast ductile iron of 93,000 psi tensile strength has the same machinability rating as gray iron with a strength of 45,000 psi.



COURTESY OF ACME SHEAR COMPANY, BRIDGEPORT 1, CONN.

4. Annealed ductile iron can be machined at a rate 2 to 3 times that of good quality gray iron.

5. It can be satisfactorily welded.

6. It resists oxidation and growth to an extent never before available in gray iron castings.

7. It can be cast in intricate shapes not normally feasible for cast steel.

AVAILABILITY

Send us details of your prospective uses, so that we may offer a list of sources from some 100 authorized foundries now producing ductile cast iron under patent licenses. Request a list of available publications on ductile iron... mail the coupon now.

Ductile Iron offers excellent castability, high mechanical properties and good machinability. Castings show superior pressure tightness, good elastic modulus and resistance to shock. They range from those weighing a few ounces... with sections as thin as one-tenth of an inch... to 50-ton anvil blocks with sections 4' thick.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 WALL STREET, NEW YORK 5, NEW YORK

The International Nickel Company, Inc.
Dept. EMJ, 67 Wall Street
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Please send me a list of publications on:
DUCTILE IRON

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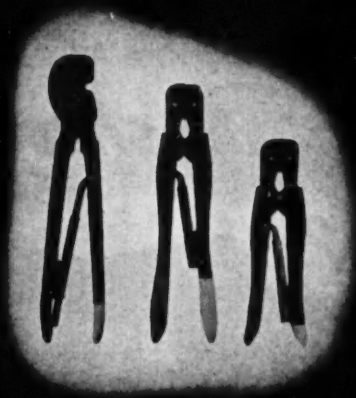
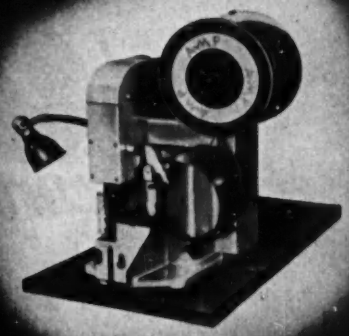
Company_____

Address_____

City_____ State_____



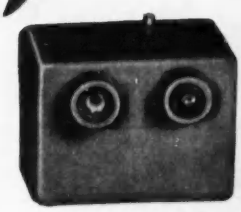


it's the Extra Factor of Assurance that counts...

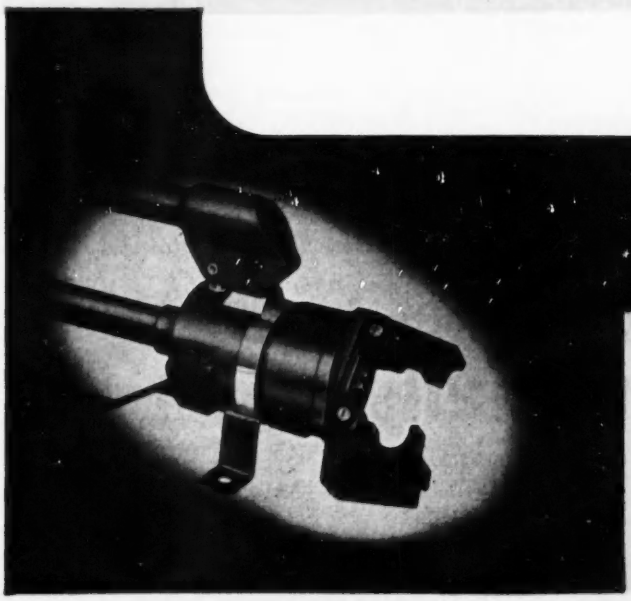
All the gadgets or combination tools in the world will not insure the correct installation of your wire terminations day in, day out, on the line. It's the extra factor of assurance that counts! AMP tools and terminals are made to use together. They're made so that you can be *sure* that you have a correctly installed termination. AMP application tools and dies and automatic machines are so designed that at the point of application you can control accuracy and uniformity within ±.003". Remember: In wire termination there is no short cut to precision and foolproof production!

Shown below: AMP CERTI-CRIMP* hand tools—will not release until proper crimping pressure has been reached. (Below right) the AMP INSPECTO-MASTER* gives continuous inspection at point of terminal application. Write to AMP for information about these and other recent developments in wire termination.

A-MP CONTROLLED WIRE TERMINATION



YOU CAN COUNT ON AMP



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AIRCRAFT-MARINE PRODUCTS, INC.

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to save you expensive grinding!

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ADDRESS DEPT. SA-38

When the exact shape and size of Tip you need is not to be found in carbide producers' catalogs, what should you do?—(1) order the Tips that seem to be adaptable, and then go to the expense of grinding them down to suit—or (2) ask CARMET to build you a die that presses the Tips to *your* designs? The answer is obvious! Save costly grinding.

Each one of the designs pictured above was pressed or preformed by us in quantity to the specific requirements of some individual customer. No excess metal remained for costly removal.

For suggestions, call or write your nearest A-L representative today. • *Allegheny Ludlum Steel Corporation, Carmet Div., Wanda & Jarvis Aves., Detroit 20, Mich.*

For complete MODERN Tooling, call

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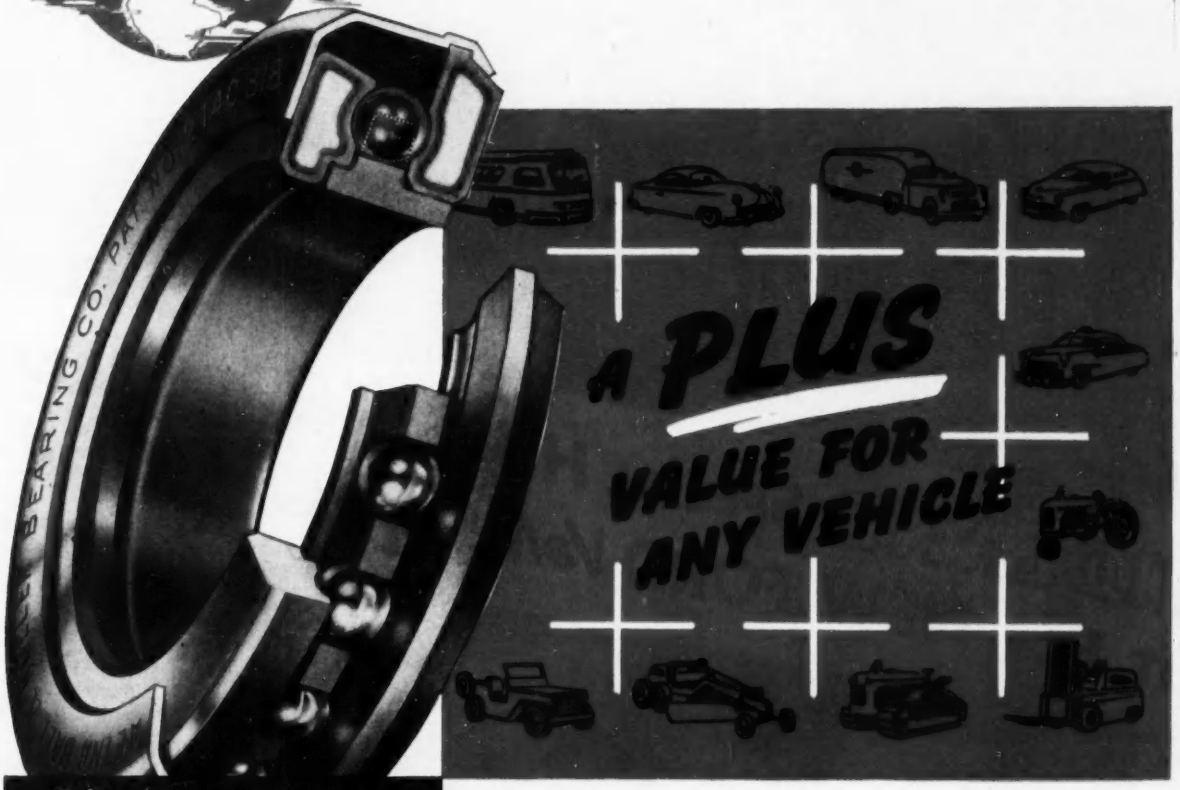
AL FINE TOOL STEELS SINCE 1854

THE WORLD-FAMOUS AETNA T-TYPE CLUTCH RELEASE BEARING



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- Large, factory-packed grease reservoir assures lifetime lubrication—no need for costly grease fittings or oil lines.
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Standard and Special Ball Thrust Bearings • Angular Contact Ball Bearings • Special Roller Bearings • Ball Retainers • Hardened and Ground Washers • Sleeves • Bushings • Miscellaneous Precision Parts.

In 1953, as in the past 19 years more of the nation's mobile vehicles will be equipped with the Aetna T-Type clutch release bearing than with any other type. Its unrivaled service life has always made it the most economical in the long run. Once installed it is trouble-free, attention-free for vehicle life. Thanks to its design and lubricant capacity there's no need of costly machining operations for oil lines or grease fittings—no need for further maintenance whatsoever. Think what that saves in man and machine hours on the assembly line, in saving up-keep costs for the vehicle owner.

It's a trusty sign of dependability and economical performance in any vehicle—the famous Aetna T-Type bearing. Investigate. Find out the many other sound reasons it deserves a place in your specifications.

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Special Installation Kits for All Popular Makes and Models of Trucks

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Are high capacity and long service life important?

here's how truck and trailer manufacturers get them with NEEDLE BEARINGS

Many leading truck and trailer manufacturers specify Torrington Needle Bearings for steering and brake assemblies because of their high radial load capacity and their long service life.

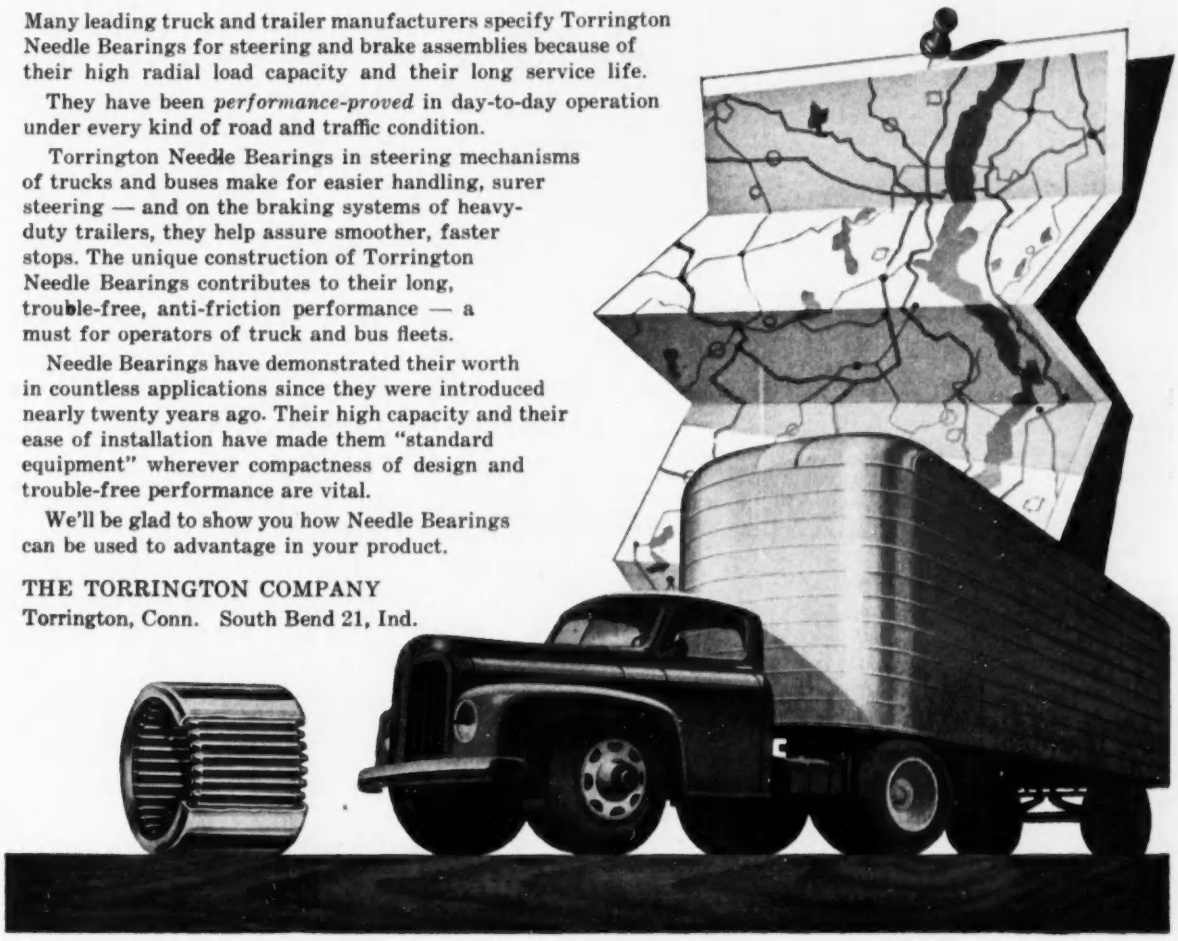
They have been *performance-proved* in day-to-day operation under every kind of road and traffic condition.

Torrington Needle Bearings in steering mechanisms of trucks and buses make for easier handling, surer steering — and on the braking systems of heavy-duty trailers, they help assure smoother, faster stops. The unique construction of Torrington Needle Bearings contributes to their long, trouble-free, anti-friction performance — a must for operators of truck and bus fleets.

Needle Bearings have demonstrated their worth in countless applications since they were introduced nearly twenty years ago. Their high capacity and their ease of installation have made them "standard equipment" wherever compactness of design and trouble-free performance are vital.

We'll be glad to show you how Needle Bearings can be used to advantage in your product.

THE TORRINGTON COMPANY
Torrington, Conn. South Bend 21, Ind.



TORRINGTON NEEDLE BEARINGS

Needle • Spherical Roller • Tapered Roller • Straight Roller • Ball • Needle Rollers

Trade-marks of some of the truck and trailer manufacturers whose products enjoy the benefits of Needle Bearings.

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We stop them all—Safely

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CLARK

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Turn and see reverse side for more about CLARK products

CLARK EQUIPMENT COMPANY, Buchanan, Michigan

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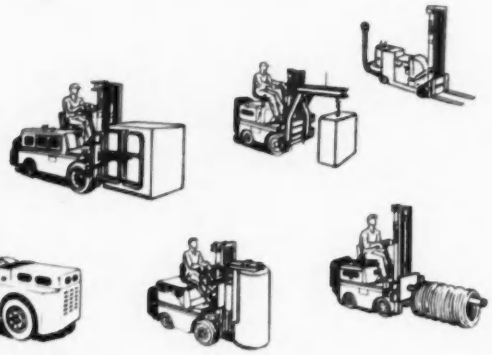
Improve Schedules—
THE ECONOMICAL WAY



Step up your schedule . . . step down your costs.

Put your materials handling system on a money-saving basis . . . speed-up the movement of raw materials, parts, products . . . load, unload, lift, move, stack . . . with a minimum of manpower, money and minutes.

Clark "job-engineered" materials handling equipment increases inventory turnover—cuts overhead costs—reduces damage to in-process materials—reduces accidents—speeds-up delivery schedules—multiplies manpower—contributes to better employee relations.

A full half-century of practical experience is back of every piece of Clark equipment. And for every handling job there's a Clark unit to do it with maximum efficiency . . . gas-powered, diesel-powered and electric battery-powered fork lift trucks, powered hand trucks, towing tractors . . . each in a wide range of styles and sizes. Talk it over with your nearest Clark dealer. You'll find him listed in the Yellow Pages of your phone book.

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AND POWERED HAND TRUCKS • INDUSTRIAL TOWING TRACTORS

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Engineered DUTY performance

DUALOY will improve the economy and efficiency of heavy duty engines.

We solicit your invitations to assist in solving design and operation problems.

SILV-O-LITE
Better Pistons Since 1922

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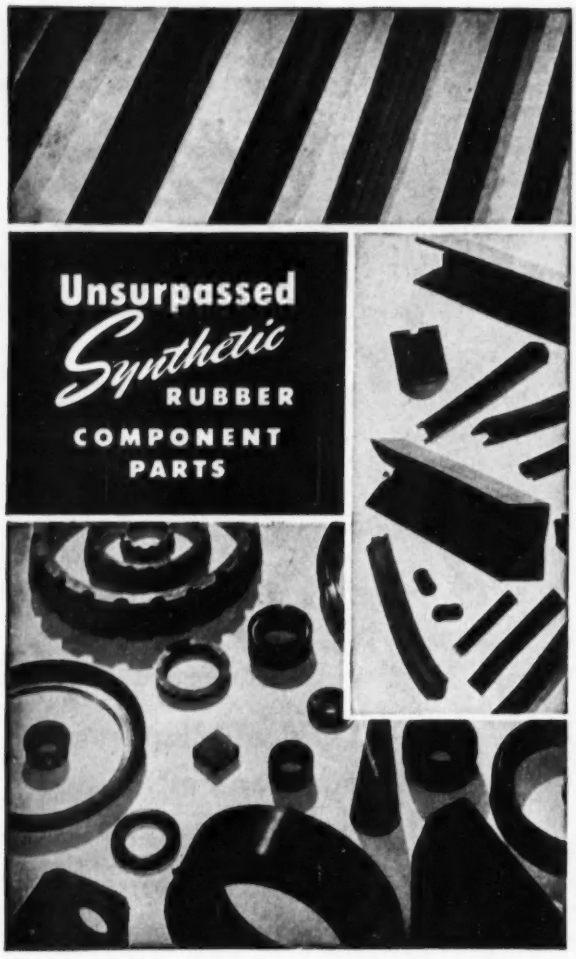
THE 1st BI-METALLIC MOLECULAR BONDED PISTON

UNITED ENGINE AND MACHINE COMPANY

310 PREDA STREET · SAN LEANDRO, CALIFORNIA



Users of Acadia Synthetic Rubber component parts in hundreds of industries have found them unsurpassed. No matter what function synthetic rubber must perform, depend on Acadia parts. They best meet exacting specifications and operating conditions such as moisture, oil, heat, wear and age resistance. Molded, extruded, die-cut to close limits—compounded to meet specific conditions. Acadia engineers will gladly cooperate.

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- "O" Rings
- Sheet
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THE GREAT NEW 1953

Dual-Streak Pontiac

★ COMPLETELY NEW DUAL-STREAK STYLING

★ NEW LONGER WHEELBASE

★ LONGER, LOVELIER, ROOMIER BODIES

★ SPECTACULAR NEW OVER-ALL PERFORMANCE

★ NEW ONE-PIECE WINDSHIELD—PANORAMIC REAR WINDOW

★ PONTIAC'S WONDERFUL NEW POWER STEERING*

A GENERAL MOTORS MASTERPIECE

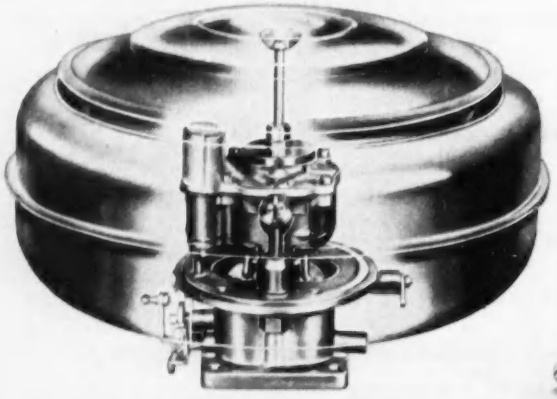
Pontiac's basic engineering aim is to design and build the most luxuriously beautiful, finest performing and most dependable car that can be built to sell at a price just above the very lowest.

The achievement of this aim has been evident year after year—but never has it been more pronounced than in the great new 1953 Pontiac—a truly wonderful car in every detail and the greatest value ever offered by Pontiac.

This great new car—plus Pontiac's overwhelming public acceptance and reputation for year-after-year excellence—offers dramatic proof that dollar for dollar you can't beat a Pontiac—a General Motors masterpiece! *Optional at extra cost.

PONTIAC MOTOR DIVISION OF GENERAL MOTORS CORPORATION

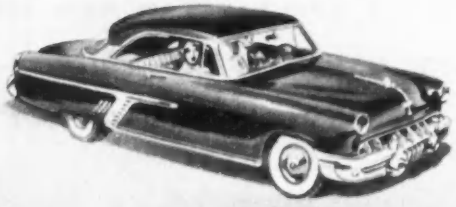
On the Top Performance You'll Find HOLLEY Fuel



The Centri-Flo is calibrated for engines of 110 to 180 horsepower.

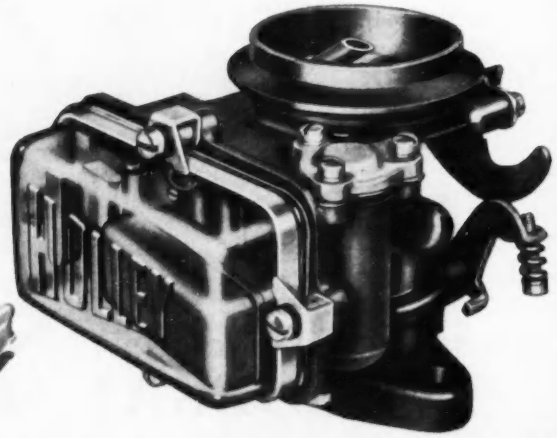
The Smooth Performing CENTRI-FLO

A true concentric carburetor designed with all important metering parts at the center line of the fuel bowl. The result—smooth, uninterrupted performance during fast stops and starts and sharp turns. The unique carburetor and air cleaner combination allows lower hood lines—meets the modern styling trends.



VISI-FLO—With The Clear Glass Fuel Bowl

Only four inches high, the Holley Visi-Flo combines economy, performance, and service features into a small package. The clear glass fuel bowl and the replaceable metering unit allow carburetor service without disassembly. The compact Visi-Flo can be used even where overhead space ordinarily requires special manifold design.



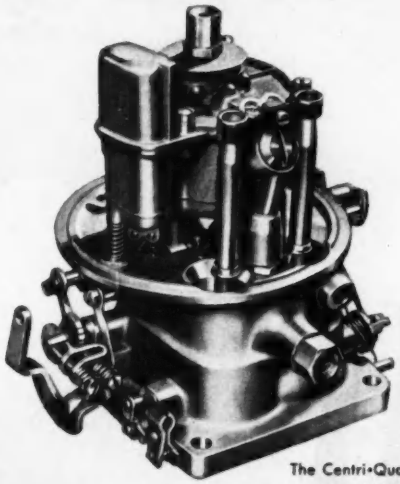
The Visi-Flo is calibrated for engines of 80 to 120 horsepower. It is also available for engines of 100 to 160 horsepower.

Each of the products shown on these two pages is a Holley "first" in the design, development, and manufacture of fuel and ignition controls. During its 53 year record of achievement, the Holley Company has played an important role in establishing higher automotive standards for performance and economy.

ARE YOU WONDERING...

How To Do A Good Job Of Fuel Metering Better? Let Holley's engineers listen, test, design, and recommend.

Cars and Trucks of 1953, and Ignition Controls



For The Best In Carburetion—The CENTRI-QUAD

Designed to add horsepower to present day engines, the Holley Centri-Quad combines the performance features of concentric design with the increased power of four barrel carburetion. The Centri-Quad is designed for the same basic air cleaner installation as used on the Centri-Flo.

The Centri-Quad is calibrated for engines of 150 to 225 horsepower.

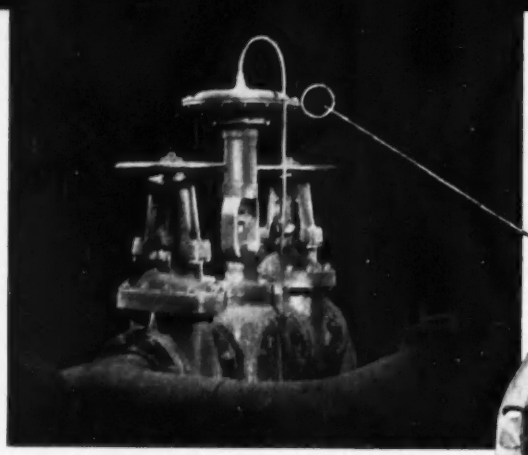
A Fully Vacuum Controlled Distributor

Using pressures which exist within the carburetor, the Holley pressure distributor meters spark in exact relation to fuel consumption—provides quicker, smoother performance, and greater fuel economy. It is the only distributor now available that eliminates the need for a centrifugal advance mechanism.

HOLLEY Carburetor Co.

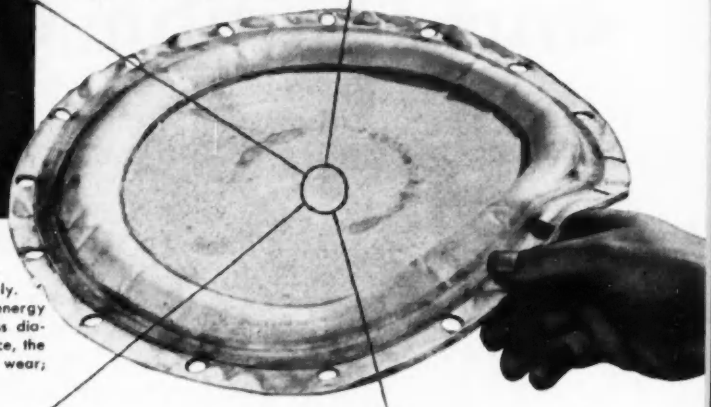
DETROIT 4, MICHIGAN

FOR MORE THAN HALF A CENTURY ORIGINAL EQUIPMENT MANUFACTURERS FOR THE AUTOMOTIVE INDUSTRY.



The diaphragm in this valve that regulates the intake to a boiler feedwater storage tank, is in almost constant motion 24 hours a day at temperatures well above 100°F. Successive synthetic rubber diaphragms lasted 7, 11 and 13 months respectively. That's unsatisfactory performance in a power house supplying energy to a large chemical plant. So they tried a Silastic coated glass diaphragm. Recently inspected after more than 78 months of service, the Silastic diaphragm was still soft and flexible; showed little wear; appeared serviceable for many more months.

As a valve diaphragm at +100°F SILASTIC outlasts heat-stable organic rubber 7 to 1



For maximum life and reliability

specify SILASTIC

the durable silicone rubber

You, too, will find that Silastic will last longer and give you more reliable service in most applications where the life of organic rubbers is limited by high temperatures, oxidation or weathering. You will also find that Silastic can be used in many cases to take the place of complicated mechanical devices made necessary by the relative instability of organic rubber.

And Silastic is in a class by itself among rubbery materials. For example, we have aged typical samples of a Silastic stock for 12 months in an air circulating oven at 350°F. After such accelerated aging, those samples showed an increase in hardness of only 18 points from 46 to 64 durometer; elongation went down from 320 to 105%; tensile strength dropped only 26 points from 557 to 531 p.s.i.; and there were no significant changes in any of their dielectric properties.

And that is almost incredible performance at temperatures high enough to change any other kind of rubber to a brittle, noninsulating material in a few hours or days at the most. When you need rubbery properties or good dielectric properties in a resilient material that will withstand weathering or long exposure to temperatures above or below the limits of ordinary rubbers, specify Silastic.

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- ☐ List of Silastic Fabricators
- ☐ Silastic Facts 10a
- ☐ "What's A Silicone?"

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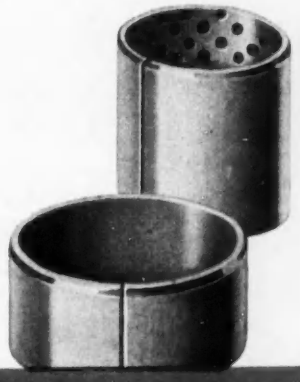
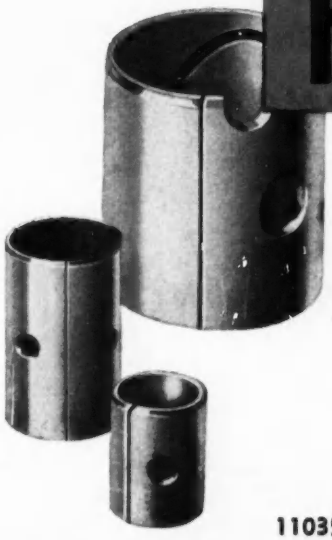
You get bearing performance at rolled bushing costs with our Bimetal Bushings. Wide variety of diameters, lengths, lining alloys, on steel backs. Write today.



FEDERAL-MOGUL



Products of our six plants include: Sleeve bearings in all designs and sizes; cast bronze bushings; rolled split-type bushings; bimetal rolled bushings; washers; spacer tubes; precision bronze parts and bronze bars.

FEDERAL Mogul

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FEDERAL-MOGUL CORPORATION

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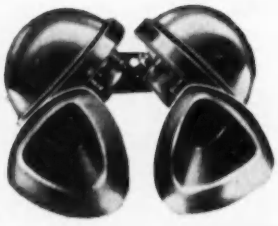
Let these Sparton horns speak for your product

The Sparton Tornado

Back in action again. A twin-trumpet electric air horn to meet the needs of engineers *and* designers. Sturdy, graceful design of chrome-plated brass. All-electric, so no installation problem. Mount inside or out, vertically or horizontally; connect to electric system. No tanks, pipes or compressor. No motor "tapping." Height 5½", width 8⅝", length 24". 12½ lbs.



The Sparton J-34

All-purpose air-shell horn fits anywhere. Twin die cast projectors are long-coiled air columns. Pleasing tone for city, plenty of "belt" for highway. Assembled on compact bracket. Mounts three ways. 6¾" high, 9½" wide, 6¾" long. 7¼ lbs.

Profit by this new lamp design

1 **Safeguards bulb** — Exclusive Sparton 45° mounting cuts shock and vibration. Prolongs bulb life.

2 **Cuts socket corrosion** — Dust, grime, moisture collect at base, cannot corrode offset socket.

3 **Allows perpendicular mounting** — Offset base permits perpendicular mounting on *any* surface.

Available in these Series 600 directional signal lamps:

Model 664-8: Semi-flush mount. Red (664) or amber (665) lenses

Model 650: Two-face, hollow-stud mount. Red and amber lenses

Model 6105-06: Flush mount. Red (6105) or amber (6106) lenses

Model 651-2: Hollow-stud, pedestal mount. Red (651) or amber (652) lenses

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WITH FORE AND AFT ADJUSTMENT

Popular for most types of mobile equipment. Quickly adjustable forward or backward with a flick of the adjusting lock-handle. Full-comfort roomy cushion seat and restful padded back. "No-Sag" synchronized action springs. Foam rubber or sisal and cotton. Artificial or genuine black cowhide.

Simple Adjustment Fore and Aft

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A-95

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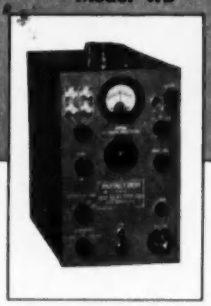

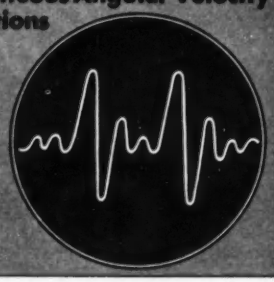

An electronic tachometer of very high angular resolution for accurate measurements of average and instantaneous angular velocity (RPM). Average RPM is measured by accurate electronic comparison method, and indicated directly on panel. Instantaneous RPM vs. time is displayed on calibrated screen of cathode-ray oscillograph, or may be recorded on a suitable recording oscillograph. Easily adapted to recording device to produce recording tachometer. High angular resolution allows use for analysis of systems in which several periods of the variation in RPM exist during one revolution.

The ROTALYZER is designed for work on systems with average RPMs varying between 500 and 9000 RPM, and will faithfully indicate instantaneous variations of any amplitude within this range, where these variations occur at rates between 0 and 500 per second. These ranges can be extended, if necessary.

Tachometer pickup head of very low inertia supplied — approximately 80 gram-cm².

Typical applications. Reciprocating and rotating internal combustion engines, as transducer in Rate Servo system, machine tool vibration analysis, study of hunting in automatic control systems, etc.

Price $1950.00 f.o.b. factory, complete with Tachometer Pickup, Electronic Analyzer Unit, Oscillograph Indicator (a specially modified DuMont 304H Oscillograph).

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KAY ELECTRIC COMPANY

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Send for free print

This chain-driven 1902 model featuring step-up design was one of the very first Franklin automobiles sold.

This is one of a series of old automobile prints that will appear in future Morse advertisements. Write for your free, enlarged copy, suitable for framing for your collection.

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Morse *means* Timing Chains?

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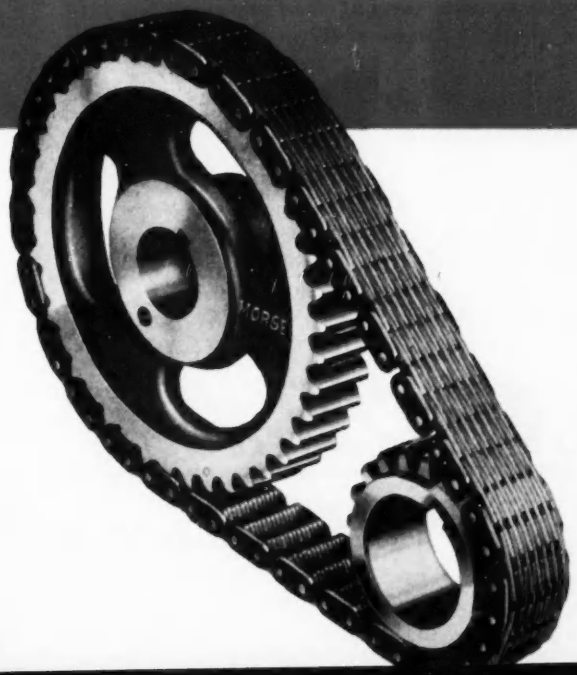

When you specify Morse Timing Chain Drives, it almost goes without saying that you get timing drives with a solid reputation for long, dependable service life in millions of cars, trucks, and buses.

You also get highly specialized engineering help in overcoming design or function problems.

Because of the proved quality of the timing chain drives and the proved quality of the engineering help, M=TC; Morse *means* Timing Chains to the automotive industry.

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If you SPECIFY or BUY Air Cleaners....

Engine analysis determines the requirements of your engine and its installation.

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DONALDSON

"Follow-through" SERVICE!

It's a multiple-service package, included with every order for Donaldson Air Cleaners. This service starts in your engineering department when dust protection requirements for your engine are outlined, and continues throughout the life of the product, assuring you and the user of dependable protection against dust.

Donaldson Air Cleaners are custom-designed to fit your particular engine and the unit for which it is the prime mover. Intensive tests in the laboratory and in the field assure you of high dust removal efficiency under all conditions.

Location counsel is another important service, recommending placement of the air cleaner and its intake after considering areas of minimum dust, operator's vision and pleasing overall design.

Finally, Donaldson "follow-through" service includes working out packaging and materials-handling problems for low-cost handling in your plant or warehouse.

What is your air cleaner problem?
Write our engineering department.

DONALDSON COMPANY, INC.
666 Pelham Blvd., St. Paul 14, Minnesota

Grinnell Division: Grinnell, Iowa
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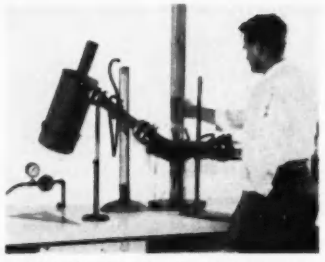
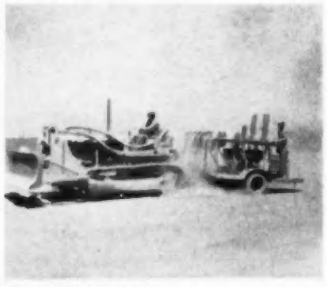
DESIGN—Donaldson engineers design the air cleaner to fit your engine.



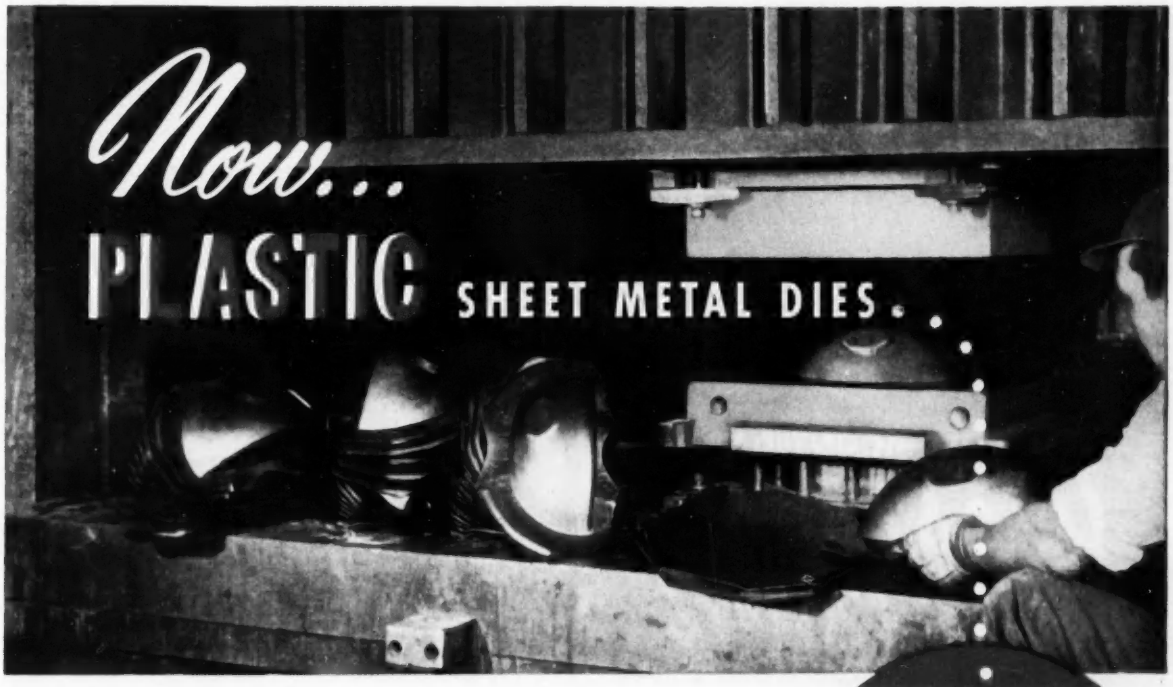
LABORATORY TESTING—Here the air cleaner is tested for efficiency under all operating conditions.



FIELD TESTING—Donaldson Cleaners are proved in action under severest of field conditions.

DONALDSON FIELD SERVICE makes sure that your equipment stays properly protected against dust.

Donaldson AIR CLEANERS



To meet the need for lowest-cost short run dies which can be produced quickly and accurately, Richard Brothers Division is now equipped to supply plastic dies.

Rezolin tool plastic material, which has proved to have good wearing qualities and stability, is being used for these dies. Because this material does not expand or shrink, dies can be made to extreme accuracy and with a minimum of final fitting and tryout. On short run production such as that illustrated—experimental flywheel housing covers of 20 gauge steel—the use of plastic dies results in definite savings both in initial cost and time required for delivery.

With the addition of the equipment and specially trained personnel required to produce plastic dies, Richard Brothers Division is now in a position to supply sheet metal dies exactly suited to any production requirement. Allite zinc alloy dies meet the needs for experimental or short run work where quantities exceed the limitations of plastic dies. For high production runs, iron dies of every type and size can be built. In many cases, combinations of materials can be utilized to provide maximum economy without sacrifice in die performance.

The best sheet metal die for the purpose . . . the most economical die for the purpose . . . can always be built for you by Richard Brothers Division. Write us for full details.

Rounding out a
COMPLETE
SHEET METAL DIE SERVICE

Other Allied Products

HARDENED AND PRECISION GROUND PARTS • SPECIAL COLD FORGED PARTS • STANDARD CAP SCREWS JIGS • FIXTURES • R-B INTERCHANGEABLE PUNCHES AND DIES

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CAN'T CRAWL

Westsorb *adhesive-coated* machine mounts are solving more than the problem of vibration. Their (exclusive) adhesive coating on both sides prevents looms and all other machinery from "crawling." Eliminates realignment after installation. This minimizes down time—saves money. Westsorb adhesive-coated felt mountings don't break down under heaviest service impacts. They resist oil, acid, grease, water and age. They are simpler to install than any machine pad. No holes or bolts—no adhesive to apply. Western Felt engineers located throughout the textile areas are anxious to cooperate.

WESTSORB
Vibration-absorbing Machine Mounts

• Quickly installed • No holes to drill • No adhesive to apply Low "down-time" • Saves floors • Less machine repair • Reduce plant noise • Thickness for every need • Engineered for every job

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Must have extensive quality control supervisory experience in the mechanical metal-working field

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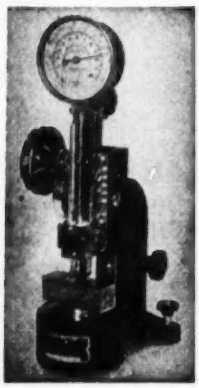

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Brinell—Shore—Scale

Included in our improved Portable Sclero-scope Model D-1. This efficient single scale tester registers Brinell-Shore values without damage to the work. The old standby for thirty-five years.

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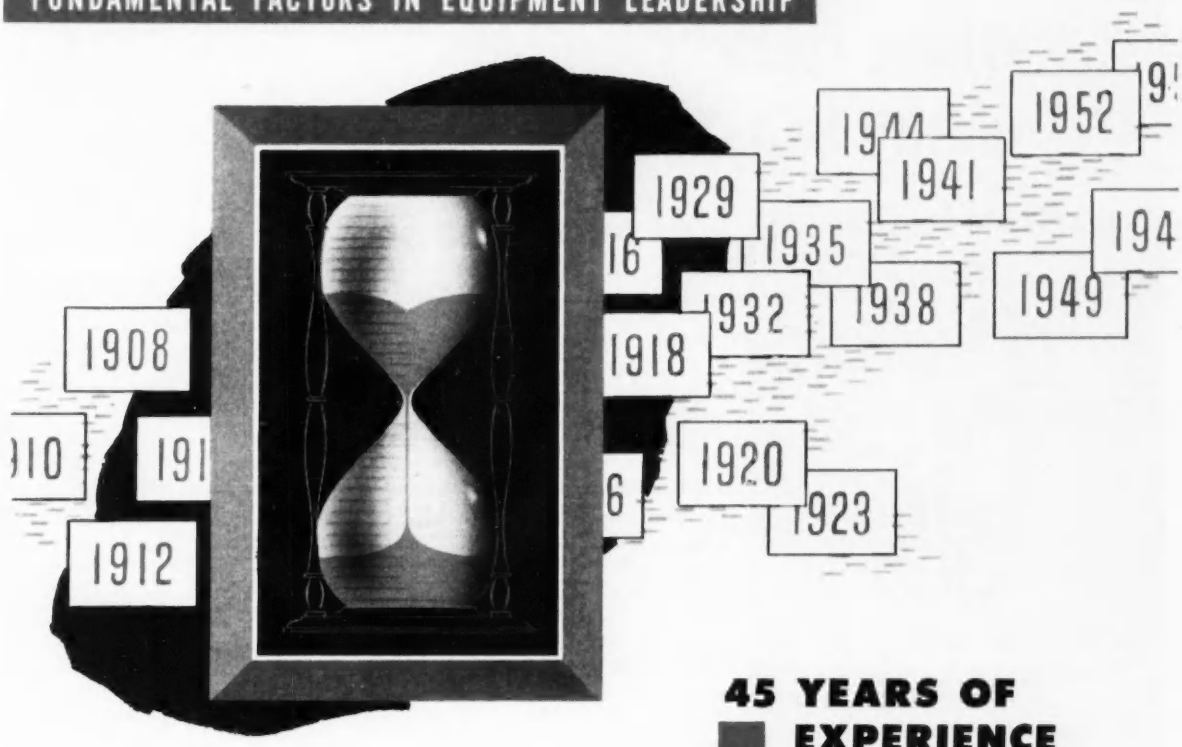

45 YEARS OF EXPERIENCE

● There is no substitute for experience . . . what an organization has demonstrated in the past, you can reasonably expect it to repeat in the future.

For years AC has been serving and supplying automotive manufacturers with equipment units of superior quality. The list now numbers more than 300 customers. AC's staff of engineering and production specialists work hand-in-hand with these manufacturing clients to help them improve the quality standards and saleability of their products.

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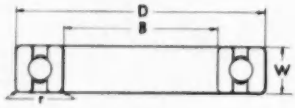

Bearing Number	Bore B	Outside Dia. D	Width W	Fillet Radius* r	Balls		Bearing Numbers	
	Inches	Inches	Inches	Inches	No.	Size	Single Shield	Double Shield
XLS-1 5/8	1 5/8	2 9/16	9/16	0.047	11	5/16	XLS-1 5/8-S	XLS-1 5/8-SS
XLS-1 1/2	1 1/2	2 11/16	9/16	0.047	12	5/16	XLS-1 1/2-S	XLS-1 1/2-SS
XLS-1 3/8	1 3/8	2 7/8	9/16	0.047	12	11/32	XLS-1 3/8-S	XLS-1 3/8-SS
XLS-1 3/4	1 3/4	3	9/16	0.047	12	11/32	XLS-1 3/4-S	XLS-1 3/4-SS
XLS-1 7/8	1 7/8	3 3/16	5/8	0.047	12	3/8	XLS-1 7/8-S	XLS-1 7/8-SS
XLS-2	2	3 5/16	5/8	0.047	12	3/8	XLS-2-S	XLS-2-SS
XLS-2 1/8	2 1/8	3 7/16	5/8	0.047	14	5/16	XLS-2 1/8-S	XLS-2 1/8-SS
XLS-2 1/4	2 1/4	3 9/16	5/8	0.047	14	3/8	XLS-2 1/4-S	XLS-2 1/4-SS
XLS-2 3/8	2 3/8	3 3/4	11/16	0.047	14	11/32	XLS-2 3/8-S	XLS-2 3/8-SS
XLS-2 1/2	2 1/2	3 7/8	11/16	0.047	16	11/32	XLS-2 1/2-S	XLS-2 1/2-SS
XLS-2 5/8	2 5/8	4 1/8	11/16	0.047	16	3/8	XLS-2 5/8-S	XLS-2 5/8-SS
XLS-2 3/4	2 3/4	4 1/8	11/16	0.047	16	3/8	XLS-2 3/4-S	XLS-2 3/4-SS
XLS-2 7/8	2 7/8	4 1/2	3/4	0.047	16	3/8	XLS-2 7/8-S	XLS-2 7/8-SS
XLS-3	3	4 1/2	3/4	0.047	16	3/8	XLS-3-S	XLS-3-SS
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XLS-6	6	8	1	0.094	23	1/2	XLS-6-S	XLS-6-SS
XLS-6 1/4	6 1/4	8 1/2	1 1/8	0.094	22	9/16	XLS-6 1/4-S	XLS-6 1/4-SS
XLS-6 1/2	6 1/2	8 3/4	1 1/8	0.094	22	9/16	XLS-6 1/2-S	XLS-6 1/2-SS
XLS-6 3/4	6 3/4	9	1 1/8	0.094	23	9/16	XLS-6 3/4-S	XLS-6 3/4-SS
XLS-7	7	9 1/2	1 1/4	0.094	21	5/8	XLS-7-S	XLS-7-SS
XLS-7 1/4	7 1/4	9 3/4	1 1/4	0.094	22	5/8	XLS-7 1/4-S	XLS-7 1/4-SS
XLS-7 1/2	7 1/2	10	1 1/4	0.094	22	5/8	XLS-7 1/2-S	XLS-7 1/2-SS
XLS-7 3/4	7 3/4	10 1/2	1 3/8	0.094	21	11/16	XLS-7 3/4-S	XLS-7 3/4-SS
XLS-8	8	10 3/4	1 3/8	0.094	22	11/16	XLS-8-S	XLS-8-SS

* Bearing corner radii will clear maximum fillet radius shown.
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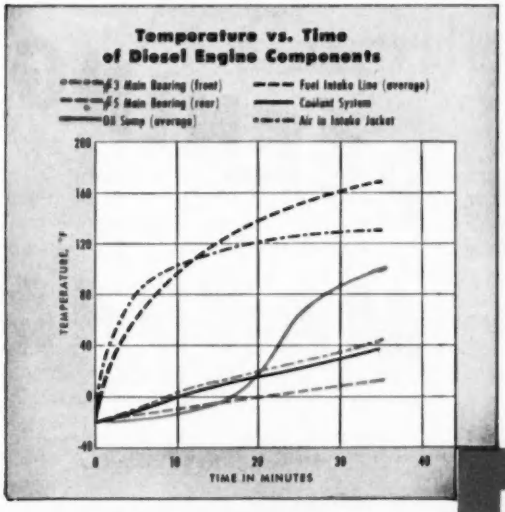

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8. Reduces cost of starting aids.
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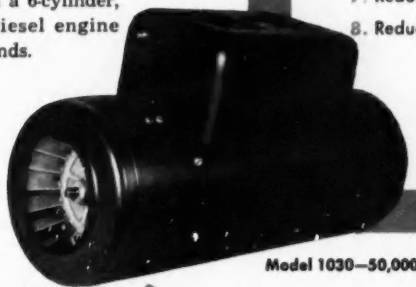

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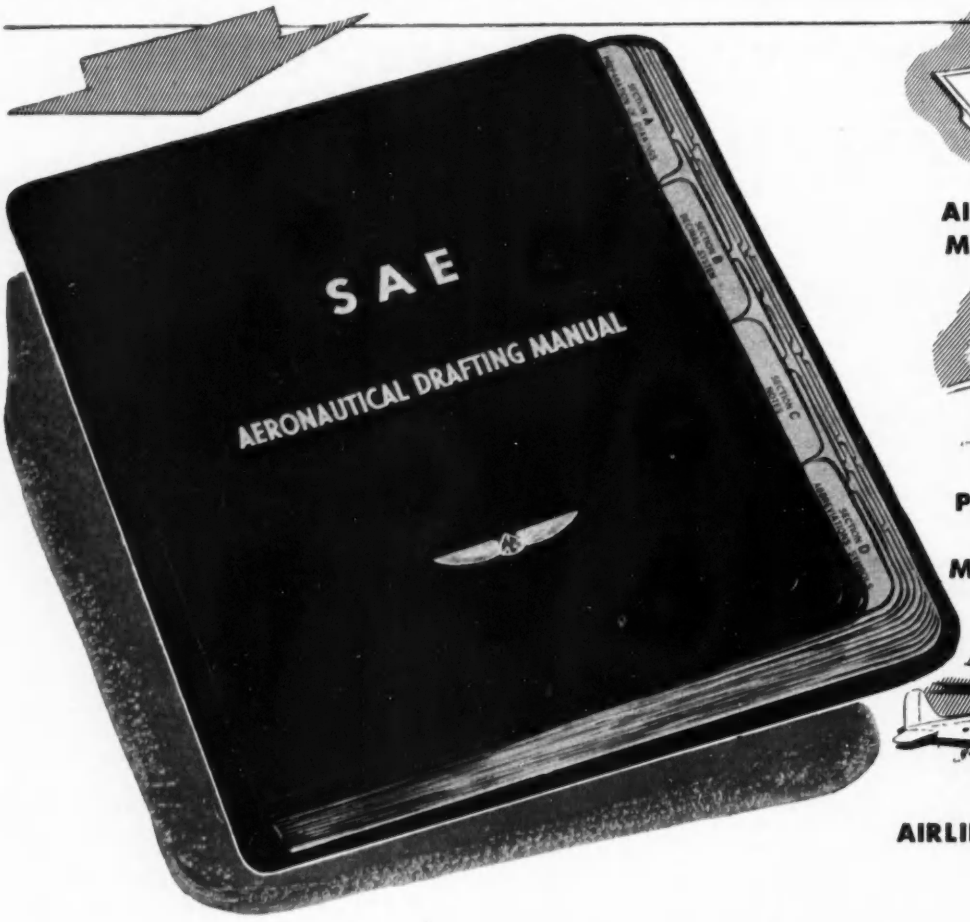

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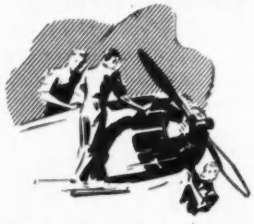

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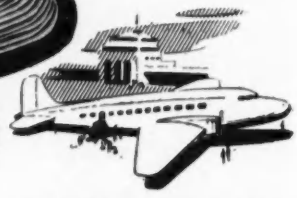

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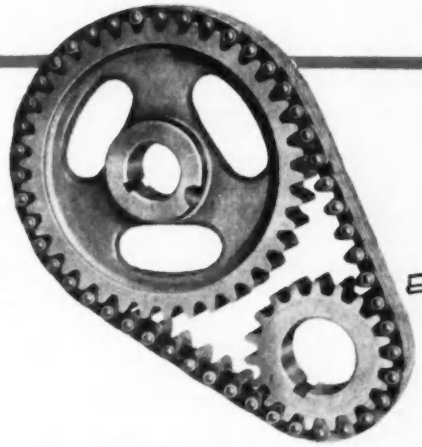

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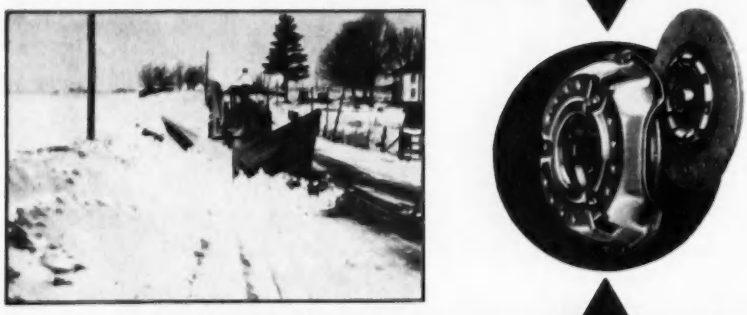

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Fuel Injection and Electrical Equipment

C.A.V. DIVISION OF LUCAS ELECTRICAL SERVICES INC., 653, TENTH AVENUE, NEW YORK 19, N.Y.
Sales Office: 14820 DETROIT AVENUE, CLEVELAND 7, OHIO

American Felt TREATMENTS GREATLY EXPAND FELT'S FUNCTIONS

Just see this list of the treatments that can be given to felt by American. They tremendously increase the usefulness and value of felt, giving it new and added qualities and advantages. Especially treated felt from American may be the answer to one or more of your problems associated with either your production or your product. Remember that felt is an engineering material, which can be specified as accurately as any other. It can be had in rolls, sheets or cut or formed parts to your exact specifications. American's Engineering and Research Department will gladly collaborate with your engineers, designers and production men. Write on your company letterhead for:

Data Sheet No. 4, Special Felt Treatments.

American Felt Company

TRADE MARK

GENERAL OFFICES: P. O. BOX 3, GLENVILLE, CONN.

SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Dallas, San Francisco, Los Angeles, Portland, Seattle, San Diego, Montreal.—PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I.—ENGINEERING AND RESEARCH LABORATORIES: Glenville, Conn.

Felt Treatment Selection Chart

SIZING IMPREGNATIONS

TREATMENT INDEX	DESCRIPTION	TYPICAL USE
No. 1 Starch Base	Slight Stiffening	Coat Front Felts
No. 2 Starch Base	Medium Stiffening	Shoe, Tongue, and Pennant Felts
No. 3 Starch Base	Stiff Size	Millinery, Furrier, and Heel Pads
No. 4 Starch Base	Extra Stiff Size	Hat Brims
No. 5 Starch Base	Double Stiff Size	Carnival Hats
Starch Base	5% to 30% Dry Solids	Stiffening
Synthetic or Natural Resin Emulsions	5% to 30% Dry Solids	Permanent Stiffening – Pre-Form Molding

TREATMENT IMPREGNATIONS

Asphalt – Water Dispersed	Weather Sealing	Cowl Seals – Anti-Squeak Chassis Strips
Graphite – Water Dispersed	Lubrication	Anti-Friction Lubricating Pads – Washers – Oil Seals
Paraffin – Petrolatum (Cut Parts Only)	Waterproof Sealing - Lubrication	Float Valve Plunger Washers – Needle Lubricating Pads
Paraffin – Graphite - Petrolatum (Cut Parts Only)	Packing - Lubrication	Marine Stuffing Box Washers
Wax – Bee's - Carnarba - Candelilla - Paraffin (Cut Parts Only)	Blocking - Sealing	Polishing Laps – Waterproofing
Natural Latex Hycar Latex Neoprene Latex Buna-S Latex	5% to 100% Dry Solids Flexible Stiffening, and strengthening	Backing Felts, Cushioning Type of Latex used dependent on conditions of use
Flame Resistance	Felt treated to specification will not propagate a flame	Aircraft and decorative felts, Clothes Dryer Felt
Fungi Resistance	Will not support fungus growth	As required by conditions of use
Flame and Fungi Resistance	Will not support Fungus Growth – Will not propagate a Flame	Felts for Acoustical and Thermal Insulation
Water Resistance	Minimum Water Absorption	Weatherstripping
Moisture - Fungi Resistance	Treated to Government Specification – Felt has Minimum Water Absorption and Will Not Support Fungus Growth	Tropicalization
Vermin Resistance	Felt non-attractive to insects	Musical or Scientific Instruments, Case Lining Felt
Moth Resistance	Resistant to carpet beetle larvae ravage	Musical or Scientific Instruments, Case Lining Felt

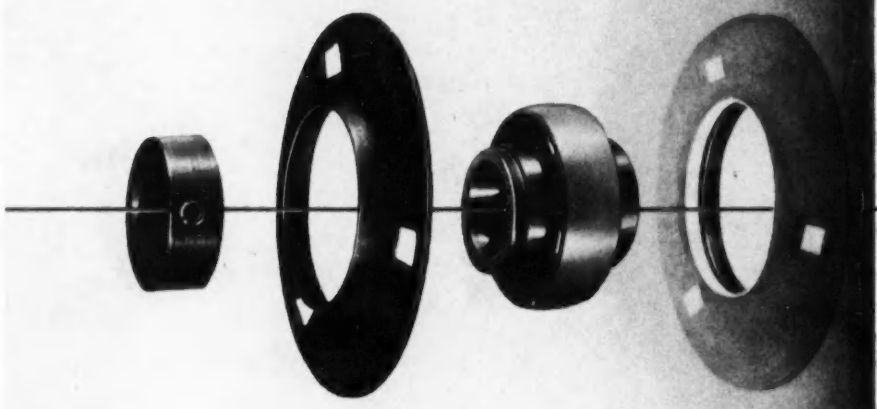
LAMINATIONS

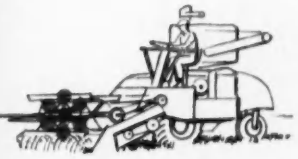
Hycar Sheeting Neoprene Sheeting Buna-S Sheeting	1/32" T and 1/64" T Impervious Septums Laminated to all Felt Densities	Oil or Water Seals, The Impervious Rubber Sheeting Functions As a Positive Dam
Hycar Rubber Vistex Natural Rubber Vistex Neoprene Rubber Vistex Buna-S Rubber Vistex	A Sheet, Laminated, Felt Base Packing, Sealing and Gasketing Material	Fuel Pump Packing Washers, Mechanical Seals for Corrosive Liquids, Oil Wipers, Shock Absorber Packing
Aluminum Foil	Laminated to Pad Felts or Special "K" Felt	Reflectant, Acoustical and Thermal Insulating Blankets

COATINGS

Latex Rubber Surface Coating (One or Both Sides)	Reinforcement, non-skid	Reinforce low grade pad felts, non-skid typewriter pads, non-skid chair pads
Rubber and Starch Sizing Coating	Stiff Reinforcement	Window Channel Felt

The Idea that caught like Wildfire!





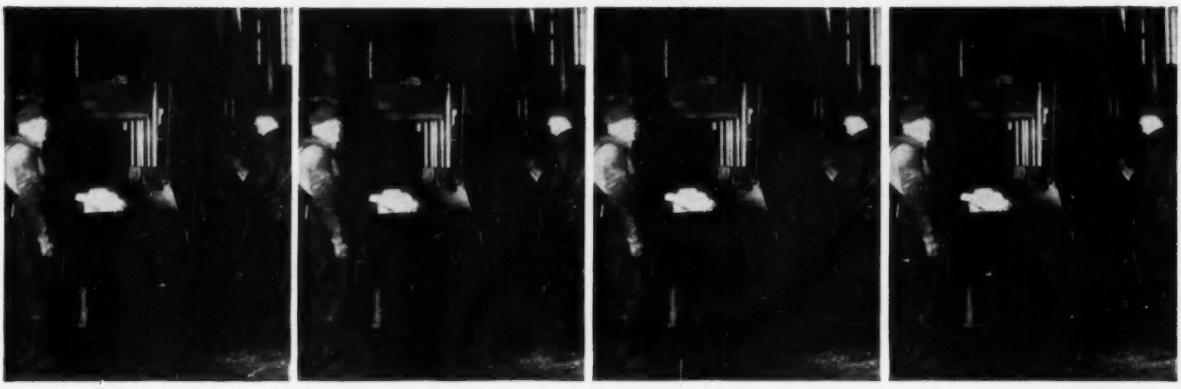
The Fafnir Flangette . . . *a pre-lubricated, completely-packaged ball bearing.*

This low-cost, easy-to-install ball bearing unit paved the way for important improvements in the design and construction of farm machinery and equipment. It cuts through cost barriers. It simplifies machinery construction. It improves overall performance. As a result, the advantages of ball bearings are available on more turning points today than ever before.

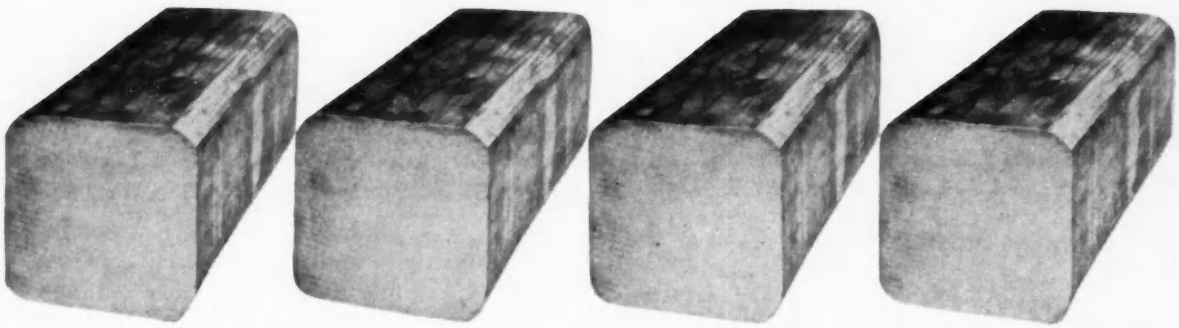
The Fafnir Flangette consists of a compact, lightweight housing of two, mated, pressed-steel flanges which can be bolted to almost any part of a machine . . . the famous Fafnir Wide Inner Ring Ball Bearing with Self-Locking Collar, easiest of all to install . . . efficient seals, which keep lubricant in and contaminants out. Flange design permits full self-alignment when installing.

This popular development reflects the Fafnir "attitude and aptitude" . . . a way of looking at bearing problems from the manufacturer's viewpoint . . . an aptitude for supplying the right bearing to fit the need. Maybe this combination can help you find a better, more economical way to use ball bearings. The Fafnir Bearing Company, New Britain, Connecticut.

To get uniform forgings here...



start with uniform TIMKEN® forging steels!



YOU can get uniform, high quality forgings and cut production costs too if you start by using uniform, high quality Timken® forging steels. With Timken forging steels, you're assured of uniform forgeability, uniform response to heat treatment, uniform machinability—from bar to bar and heat to heat. As a result, you have fewer rejects, fewer delays, fewer changes in shop practice.

The uniformity of Timken forging steels is the result of rigid quality control from melt shop through final inspection. For example, the Timken Company uses the direct reading spectrometer—first in the industry—to make possible instantaneous control and checking of every heat before it's tapped.

To learn how you can improve the quality of your forgings, cut production costs or both—get an "on-the-job" analysis by our Technical Staff. And for our bulletin No. 31, "Chemical Composition of Alloy Steels", write on your company letterhead to The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

TIMKEN
Fine Alloy
STEEL

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING